

2.5. Changes in marine bird populations

“Unregulated hunting of birds in the 19th Century greatly reduced some populations but enactment of the Migratory Birds Convention Act and other laws, coupled with improved enforcement, has permitted most shorebirds and waterfowl to recover, although birds of prey still suffer from indiscriminate shooting because of prejudiced attitudes which change slowly.” (Christie 1979)

“It is this mixture of dynamic oceanography and high productivity which makes the Quoddy region such a useful migratory staging area for the red-necked phalaropes. [...] The fact that such a large proportion of the North American population of red-necked phalaropes stages in this area, as well as large numbers of shorebirds, gulls, terns, whales and porpoises, attests to the importance of the Quoddy region.” (Mercier & Gaskin 1985)

“A major decline in the numbers of [phalaropes] staging in the Quoddy region began in 1986 and by 1990, the species was essentially absent.” (Duncan 1996)

“ In recent years, observations of wintering harlequin ducks have been limited to a handful of sites in eastern North America, i.e. very inaccessible headlands, offshore skerries, and/or park reserves, all typical of wildlife refugia.” (Goudie 1989)

2.5.1. Importance of the Quoddy Region for marine birds

The area around Passamaquoddy Bay and the West Isles and Grand Manan archipelagos is one of the Important Bird Areas (IBA) in Canada designated by the Canadian Nature Federation, and has been proposed as a Natural Area of Canadian Significance (Hardie 1979), an Ecological Reserve (Hunter 1982), as well as other marine conservation designations (Huettmann & Diamond 2000). For many seabirds, the area is ecologically linked to the offshore Machias Seal Island, located 20 km southwest of Grand Manan, which is protected as a Migratory Bird Sanctuary. I therefore included Machias Seal Island in my consideration of changes in bird populations over the last centuries.

The highly dynamic oceanography, the enormous productivity and the rich habitat diversity in this region (see Chapter 1) support critical feeding, breeding, wintering and staging areas for over 200 species of seabirds, shorebirds and waterfowl (Hardie 1979, CWS 1979, Christie 1983). All these species have their own specific set of temporal and spatial needs for nesting, nursing, foraging and roosting and thus have their own niche. Based on the concentration and diversity of species and niches, the Quoddy Region including Machias Seal Island appears to be an oasis for birds, especially seabirds and waterfowl, not only in the Bay of Fundy but also in the entire Northwest Atlantic Ocean (CWS 1979, Lock et al. 1994, Hicklin 1996, Huettmann & Diamond 2000). For many species, this is the only or the most important area in Eastern Canada (see below). Because salt marshes and mud flats are less abundant in the area compared to the upper Bay of Fundy (ca. 180 ha in Passamaquoddy Bay and 280 ha in the Grand Manan archipelago), the highest concentrations of migratory shorebirds are found in early fall in the inner part of the Bay of Fundy, a secondary oasis in the bay for these species (Hicklin & Smith 1984, Lock et al. 1994).

Altogether 300 species of birds have been reported to occur in the Canadian portion of the Quoddy Region, 220 of which occur regularly (Christie 1983). Of these, 91 species are present mainly in summer, 33 mainly in winter, 42 occur throughout the year, and 54 primarily pass through during migration (Christie 1983). Some of these species migrate over vast distances and their movements link

the Quoddy Region with areas half way around the globe, from the high Arctic to the sub-Antarctic, the Pacific and Europe (Christie 1983). Thus, in terms of bird species, the Quoddy Region including Machias Seal Island is of global importance.

For a number of northern species such as Northern gannets, Atlantic puffins, Common murre, Razorbills, Common and Arctic terns, Black-legged kittiwakes and the endangered Roseate tern, the Bay of Fundy is the southern limit of their breeding ranges. Other seabirds such as dovebies and Black-legged kittiwakes breed in the Arctic and use the Quoddy Region area as a wintering ground. The same is true for many waterfowl, such as the endangered Harlequin duck and some shorebirds such as the Purple sandpiper (Lock et al. 1994). Some seabirds breeding in the southern hemisphere such as shearwaters and Wilson's storm-petrel, spend their winter in the study area (Lock et al. 1994). Species that breed further north and winter further south use the area as a staging ground on their southward migration in fall or their northward migration in spring. These include shorebirds such as the Red-necked phalarope and Semi-palmated sandpiper, seabirds such as the Arctic tern, Common tern and Bonaparte's gull, and waterfowl such as scoters (Gaskin & Smith 1979, Braune & Gaskin 1982a, Lock et al. 1994, Hicklin 1996). At all seasons some of the highest concentrations of waterfowl in the Bay of Fundy are to be found in Passamaquoddy Bay as well as on the eastern shore of Grand Manan, e.g. breeding Common eiders and wintering American black ducks (Lock et al. 1994). This area is also important for several breeding pairs of Bald eagles, ospreys, and other raptors such as the Peregrine falcon.

2.5.2. Ecology of marine birds – habitat and food needs

Nearshore intertidal areas support Brants, Black ducks, Common eiders and other dabbling ducks and geese (Hicklin & Smith 1984). Eelgrass is the preferred food for migrating Brants and Canada geese (Brown 1974, Erskine 1997b), while Common eiders prey upon Blue mussels and periwinkles (Hamilton 2000). Shallow coastal areas around islands and ledges support Black guillemots feeding on small benthic and demersal fish (e.g. rock gunnels) and shrimps (*Pandalus* spp.) (Nol & Gaskin 1987).

The most significant feature of the area is the upwelling occurring in the passages such as Head Harbour, L'Etete and Western Passage. Here, large aggregations of crustacean zooplankton, notably copepods and euphausiids, are found (Gaskin & Smith 1979). Copepods, mainly immature *Calanus finmarchicus* and adult *Pseudocalanus minutus*, are the principal food for the Red-necked (northern) phalarope (Gaskin & Smith 1979, Mercier & Gaskin 1985, Brown & Gaskin 1988, Lock et al. 1994). Euphausiids, mainly *Meganyctiphanes norvegica* and *Thysanoessa* spp., are the main food for Bonaparte's gull (Gaskin & Smith 1979, Hicklin & Smith 1984, Braune & Gaskin 1982a, b), and are also important for Arctic terns (Braune & Gaskin 1982a), Herring gulls and Great black-backed gulls, and Red-necked phalaropes (Gaskin & Smith 1979). Euphausiids are a principal food for "wintering" shearwaters (in North' summer), but mainly off Brier Island, Nova Scotia (Lock et al. 1994). Areas with low euphausiid concentrations are used mainly by Arctic terns.

Areas with high currents off L'Etete Passage, Back Bay and Bliss Harbour contain high abundances of small, schooling fish (mainly herring, pollock), which support Common and Arctic terns (Braune & Gaskin 1982a, b), Herring gulls, Northern gannets, and Black-legged kittiwakes (Gaskin & Smith 1979). Salt marshes and mud flats are not extensive compared to the upper Bay of Fundy, but support some migrating waterfowl and shorebirds, respectively (Hicklin 1996). Shorebirds such as the Semi-palmated sandpiper forage for crustaceans, e.g. *Corophium voluntator* (Hicklin & Smith 1984). In recent years, increasing numbers of larger gulls such as Herring gulls and Great black-backed gulls prey on Eider ducklings and chicks of various other ducks and seabirds (Gaskin & Smith 1979, Mawhinney et al. 1999, Hamilton 2000a). Garbage dumps and offal from fishing vessels and fish processing are important

additional food sources especially during food shortage in winter (Gaskin & Smith 1979).

2.5.3. History of change and human impacts on marine birds

Direct human impacts

Hunting of birds for food has taken place since people were present in the region. From bone remains found at archaeological sites of native settlements in the Quoddy Region the following species could be identified: Common loon, Wood duck, Brant, Goldeneye, Common eider, Great auk, Common murre, Thick-billed murre, Greater shearwater, Passenger pigeon, eagle, and Osprey (see Chapter 2.1, Bishop & Black 1988, Murphy & Black 1996). With European settlement in the late 18th century, however, hunting pressure on birds as well as on mammals and fish increased rapidly.

Many bird populations, especially larger migratory species, were greatly diminished by uncontrolled hunting in the late 19th century. The first protection laws were introduced in the early 20th century, i.e. the Migratory Birds Convention Act in 1928 (Table 2.5.1). Since then, many shorebirds are slowly recovering, e.g. the Lesser (American) golden plover, Whimbrel, and Red knot (Christie 1979). Other species were hunted to extinction (Passenger pigeon and the Labrador duck), are almost extinct today (Eskimo curlew), or were extirpated but re-colonized from adjacent provinces (Willet) (Table 2.5.2, Christie 1979, NGS 1987, COSEWIC 2000).

Similarly, many waterfowl were intensely hunted or exploited for egg and down collection in the 19th century until by 1900 only a few were left. After tightening of hunting regulations in 1920s, a general increase could be observed in many species, e.g. Common eider, Canada goose and various ducks (Christie 1979), but others have remained at low population levels or reached endangered status, e.g. Harlequin duck (Goudie 1989). The Canada goose, among others, is still being hunted today (Erskine 1997c).

Larger seabirds such as Herring gulls, Great black-backed gulls, and Double-crested cormorants were not primarily hunted for food, but fishermen systematically shot them and disturbed their nests because of supposed competition for fish (Christie 1979). As yet, there is no scientific evidence that the systematic killing (culling) of any marine predator has benefitted commercial fisheries (Tasker et al. 2000, Yodzis 2001). In the 1800s and into the mid-1900s, collection of Herring gull and Great black-backed gull eggs for food was very common (Christie 1979). Interestingly, this led to an observed behavioral response of Herring gulls. Between 1833-1850 it was observed that the gulls moved their nests from the ground up into trees to minimize egg losses (Perley 1852). They now nest on the ground. Raptor populations also suffered greatly from shooting, trapping and nest disturbance, until protective laws were enacted in 1960s and 1970s (Christie 1979).

Another significant human threat came from the millinery trade in nearby Maine, which used the long tail feathers of terns for hats. This greatly reduced numbers of terns along the Maine coast and probably also along the southern New Brunswick coast in the late 19th century (Christie 1979). Pettingill (1939) reported that Passamaquoddy Indians were shooting gulls, terns and eiders around Grand Manan for the millinery trade. After protection, some seabird colonies increased again. Others continued to decline because of increasing predation and disturbance by gulls, cats, rats, sheep (Christie 1979), and introduced raccoons and foxes (Winn 1950, Ingersoll & Gorham 1978). As a consequence, in the early 1900s many colonies of terns, razorbills and Black guillemots close to the mainland and on the larger islands such as Grand Manan were abandoned, while those on remote Kent Island and Machias Seal Island increased (Winn 1950, Christie 1979).

Today, bird hunting is strictly regulated by laws and managed areas. From 1969-78, recreational

migratory bird hunters shot 2,542 ducks, 24 Canada geese, and 1,538 snipes and woodcocks in Charlotte County (CWS 1979). Since 1973, the hunting of Canada geese in all of New Brunswick increased from 610 birds in 1973 to 5,357 in 1990, although there were fewer permits issued during that period (Erskine 1997c).

Table 2.5.1. *Historical changes and human impacts on seabirds, waterfowl, shorebirds and raptors in the Passamaquoddy – Grand Manan region including Machias Seal Island (Perley 1852, Pettingill 1939, Winn 1950, Christie 1979, 1983, CWS 1979, Brown 1974, Squires 1976, Ingersoll & Gorham 1978, Goudie 1989, Lock et al. 1994, Duncan 1996, Hicklin 1996, Erskine 1997a, b, COSEWIC 2000, Hamilton 2000b).*

Time (A.D.)	Activity
1800s-1920s	Unregulated hunting, egg and down collection, nest disturbance of seabirds, shorebirds, waterfowl and other birds
	Decline of herring gulls, great black-backed gulls, double-crested cormorant due to nest disturbance and shooting
1833-1850	Herring gulls observed to shift their nests from ground up into trees due to human disturbance and egg collection
1844	Extinction of the Great auk
1845	Labrador duck reported as common in the Bay of Fundy
1866	Desertion of the only Northern gannet breeding colony in NB due to lighthouse construction and egg collection on Gannet Rock.
1871	Last New Brunswick record of the Labrador duck on Grand Manan
1873	Harlequin ducks considered as common in winter in the Grand Manan archipelago
1874	Introduction of Red foxes to Grand Manan
1878	Extinction of the Labrador duck
1870-1880	Disappearance of Great black-backed gulls as a breeding bird
1880	Formerly abundant Passenger pigeon is noted as rare
1880s	Destruction of breeding grounds of Semipalmated plover by foxes
1883	Extermination of huge Herring gull breeding colony on Grand Manan by introduced foxes
1882, 1895	Breeding of Great cormorants observed at Maces Bay, but never thereafter
1895	Red foxes are highly abundant on Grand Manan
late 1800s	Lesser golden plover, Whimbrel, Eskimo curlew, Willet, Red knot and various other shorebirds almost extirpated
	Alarming reduction of Common eider and various other waterfowl; decline of terns due to millinery trade in Maine
1899	Last record of Passenger pigeon in New Brunswick
1900	Extirpation of former native breeding stocks of Canada goose
1905	Introduction of raccoons to Grand Manan
	Red foxes become scarce on Grand Manan
1914	Extinction of the Passenger pigeon
1915-1935	Shift of tern breeding colonies from islands around Grand Manan to Machias Seal Island
1920s	Tightening of hunting regulations
1928	Enactment of the Migratory Birds Convention Act
1930s	Reappearance of Great black-backed gulls as breeding birds
	Disease of eelgrass affect Brant
	Decline of Roseate terns due to gull predation
1935	Abandonment of breeding colonies of Razorbill auks on Yellow Murre Ledge / Grand Manan
1940s	Extermination of large breeding colony of Black guillemots on Grand Manan by introduced raccoons
1944	Designation of Machias Seal Island as a federal Migratory Bird Sanctuary
1948	Last breeding record of Peregrine falcons in New Brunswick
1960s-70s	Protective laws against shooting of hawks and falcons
1966	Re-colonization of Willet from Nova Scotia to New Brunswick
1972	Return of Northern gannet to the region without breeding
1980s	Re-establishment of breeding Common murrens on Yellow Murre Ledge / Grand Manan
1986	Major decline of Red-necked phalaropes
1988	Release of captive Canada geese to support wild breeding stocks on Grand Manan
1990	Abandonment of traditional staging area by Red-necked phalaropes
1994	Re-establishment of breeding Common murrens on Machias Seal Island
1999	First return of 1 breeding pair of Northern gannets on White Horse Island / Deer Island
	First return of 1 breeding pair of Peregrine falcon on Seven Day's Work / Grand Manan

Indirect human effects

Habitat alteration such as the clearing of hardwood forest may have had negative effects on the Passenger pigeon (Christie 1979). Extensive loss and degradation of wetlands in the 19th and 20th centuries has contributed to the decline of shorebirds and waterfowl in eastern North America (Morrison et al. 1994) and likely in the study area. Settlement of main and remote islands by Europeans may have negatively affected many breeding birds around Grand Manan. For example, Pettingill (1939) reported that formerly large colonies of Herring gulls on Grand Manan were forced to nest on certain portions of land not used by humans. Lighthouse construction on Gannet Rock in the Grand Manan archipelago was one reason for the desertion in 1866 of the only breeding colony of Northern gannets in this province (Christie 1979). On Machias Seal Island, a similar development caused a reduction in the numbers of Atlantic puffins and forced Razorbill auks to nest only at Yellow Murre Ledge (Pettingill 1939).

In recent decades, however, the abandonment of human settlements on remote islands may be one reason for the increasing numbers of some breeding species, such as Black-legged kittiwakes, Common murre, and Northern gannets on islands near Grand Manan (CWS 1979, Lock et al. 1994). Protected areas on Machias Seal Island, Kent Island (near Grand Manan), Barnes and Mowat Islands (West Isles archipelago), and Salkeld Island (Maces Bay) (see Harvey 1994) provide less disturbed habitat for many marine birds. Many other islands important to marine birds, however, are still lacking protection status, although many were proposed for designation as ecological reserves, as part of a larger protected "Special Ecological Region" (Hunter 1982), or as a "Natural Area of Canadian Significance" under Parks Canada (Hardie 1979). Until now, none of these designations have been made. Instead, increasing tourism by bird watchers, hikers, beach combers, and boat traffic could cause increasing disturbance of breeding, feeding or roosting birds and destruction of nests on beaches and grasslands (Christie 1979). For example, 600 people per year visit Machias Seal Island to watch birds (CWS 1979).

The introduction of formerly absent nest and bird predators to Grand Manan, such as Red foxes in 1874 and raccoons in 1905, caused many ground breeding birds to decline or disappear (Pettingill 1939, Ingersoll & Gorham 1978). Without a natural predator, these animals multiplied and soon overran the main islands. Huge colonies of Herring gulls on Grand Manan rapidly dwindled and finally disappeared in 1883 because of fox predation (Pettingill 1939). Smaller islands off Grand Manan, which could be reached by foxes or raccoons during ebb tide, were invaded and ground-breeding birds were almost depopulated, e.g. the Semi-palmated plover and Herring gulls (Pettingill 1939). This indirectly affected other birds. In seeking new territories, Herring gulls resorted to the remote exposed, treeless islands and usurped the breeding colonies of terns (Pettingill 1939). Terns, then, were observed to shift their breeding grounds to Machias Seal Island during 1915-1935 (Christie 1979). Raccoons caused Black guillemot colonies on Grand Manan to disappear, while safe colonies on Kent Island and Outer Wood Island flourished (Pettingill 1939, Winn 1950). After becoming highly abundant in 1895 on Grand Manan, Red foxes were trapped and hunted to reduce their numbers (Ingersoll & Gorham 1978). In 1905, Red foxes were uncommon and some time later again were absent from the island (Ingersoll & Gorham 1978). Raccoons are also absent.

Heavy use of pesticides, especially aerial spraying of DDT in forestry, in the 1960s and 1970s seriously impacted reproduction (thinning of egg shells) of raptors such as Bald eagles, Ospreys and Peregrine falcons (Christie 1979), and seabirds such as gulls, cormorants, Storm petrels and Atlantic puffins (Wells et al. 1996). The banning of DDT in North America was followed by a slow decline in DDT content in seabird eggs from 1968-1984 (Wells et al. 1996), probably contributing to the recovery of raptors and seabirds in the Bay of Fundy. Other contaminants detected in seabird eggs or tissues are radionuclides, PCBs, heavy metals and other persistent or toxic substances (Wells et al. 1996).

Oil spills are a major threat to many waterfowl and diving seabirds because the oil destroys the waterproofing and insulation of the plumage and causes internal pathologies when swallowed (Lock et al. 1994). In the outer Bay of Fundy, the number of recorded oil spills from 1985 to 1992 varied between one and nine per area (category I-II, Lock et al. 1994). This number increased up to the highest category IV, between 100-733 oil spills, near and in Saint John Harbour, which is a major oil port (Lock et al. 1994).

The establishment and growth of European settlements during the past 200 years was accompanied by an increase in garbage dumps, fish-processing plants, and discharges from fishing vessels. This significantly increased the availability of supplementary food for many scavengers such as Herring and Great black-backed gulls especially in winter (Christie 1979). In recent years, however, the closure of garbage dumps and the decline in traditional fisheries may reverse these effects and possibly induce negative effects such as increasing gull predation on ducklings and chicks of various birds such as Common eiders (Mawhinney et al. 1999, Hamilton 2000a) and terns (Christie 1979).

Other indirect human impacts come from the accidental killing of birds by fishing gear (reviewed in Tasker et al. 2000), although no data are available for the study area. Changes in fisheries over the last decades may have altered food availability for some birds. For example, a periodically higher or lower abundance of small prey fish such as herring and small groundfish may have affected fish foraging birds (see Chapter 2.3, Tasker et al. 2000). Increasing low-trophic level harvesting may also diminish some food sources (e.g. periwinkle, sea urchin, and crab harvest) and habitat (rockweed harvest) for other birds (see Chapter 2.4, DFO 1999, Hamilton 2000b, Rangeley & Davies 2000).

Further impacts come from relatively recent finfish aquaculture. In its search for room to expand, the salmon aquaculture industry is moving into areas that are important sites for marine birds for breeding, feeding, nursing and overwintering, particularly off islands in the Grand Manan Archipelago and Maces Bay. While an aquaculture site proposed for the Kent Island bird sanctuary was rejected, three new sites were approved in back of Wood Island and Outer Wood Island, and one new site off southern White Head Island. Approval for a site off the northern tip of White Head was deferred. Three site applications around Cheney's Island, in both Cheney and Cow Passage, are pending for approval in 2002. In total, 28 sites are either approved or awaiting approval in the Grand Manan Archipelago, with the newer sites encroaching more directly on uninhabited islands. One site was approved in 2001 on the Maces Bay Ledges, southeast of the Salkeld Islands (DAFA 2001).

For marine birds, issues related to aquaculture operations include direct loss of habitat due to cage placements, the entanglement of birds in predator exclusion nets, increase in predatory birds such as Black-backed gulls and Bald eagles due to food availability at cage sites, shooting of predatory birds by aquaculture operators, and the disturbance of breeding or wintering birds from nesting, brood rearing or feeding sites due to cage service boat traffic (K. McAloney, *pers. comm*). CWS has received funding for five years from DFO to survey migratory bird numbers and their distribution in relation to aquaculture areas. Also, a seabird-salmon aquaculture working group has been formed to address issues of seabird-aquaculture interactions and assist in developing codes of practice to mitigate impacts. Impacts could be mitigated by (1) avoiding key bird habitat altogether, (2) codes of practice specifying net sizes small enough to prevent bird entanglement, (3) proper management of fish foods and harvest waste so as to be unavailable to predatory birds, and (4) awareness course for cage workers, codes of practice for access routes, boat speed, etc. (K. McAloney, *pers. comm*).

As of December 2000, all new cage site applications must be reviewed under the Canadian Environmental Assessment Act (CEAA); as part of that review the Canadian Wildlife Service screens proposals with respect to potential impacts on migratory birds and recommends mitigating action. The approval authorities for new aquaculture sites (Fisheries and Oceans Canada, and the NB Dept. of Fisheries, Aquaculture and Agriculture (DAFA) are not obliged to accept or implement CWS

recommendations for site applications. Even so, in 2001 two proposed aquaculture sites were rejected because they were close to important Harlequin duck areas (K. McAloney, *pers. comm*). But, as the industry expands, the pressure for sites around remote islands becomes a serious issue. Because of the lack of intense human activities in the past, many of these islands have provided the foundation for the recovery of marine bird populations (see above). These positive trends may be reversed over the next decade as industrial activity infringes on nesting and nursery areas on those uninhabited islands.

Environmental change

Between 1930-33, a worldwide eelgrass disease greatly diminished the abundance of eelgrass meadows in the Northwest Atlantic including the Bay of Fundy (Mounce 1937). Because eelgrass is the preferred food for brant and Canada geese, the decline and regional disappearance of eelgrass beds likely affected their populations (Brown 1974, Erskine 1997b). Although eelgrass has partly recovered, a decline of brant in recent decades was attributed to a recent decline of eelgrass (Brown 1974).

A shortage in food supply may also have caused the recent abandonment of traditional feeding sites in the West Isles region by red-necked phalaropes (Lock et al. 1994). This was assumed to be linked to declining numbers of copepods in this region. However, similar declines in phalarope numbers near Brier Island could not be linked to changes in food abundance (Brown 1991 in Duncan 1996). Shifting feeding habits and feeding grounds, shifting migration routes, and breeding range expansions or contractions due to climate change may be further reasons causes of shifts in the distribution of bird populations (Christie 1979, Clair et al. 1996). Weather patterns at breeding grounds in the Arctic were related to varying population trends of many shorebirds over the last decades (Morrison et al. 1994).

2.5.4. Abundance and distribution of marine bird populations

Comments on the data sources and data quality.

To evaluate the abundance, distribution and population trends of marine birds in the study area, I used the following data sources:

- 1) Seabird Colony Surveys (SCS) from Canadian Wildlife Service (CWS), survey blocks 1-6 (Grand Manan), 7-18 (Quoddy region) and 25 (Machias Seal Island)
- 2) Coastal Surveys from CWS, survey blocks 1-18 and 25
- 3) Christmas Bird Counts (CBC) from the Audubon Society, USA, for Blacks Harbour and Grand Manan (<http://birdsource.tc.cornell.edu/cbcdata/>)
- 4) North American Breeding Bird Surveys (BBS), trend-data for New Brunswick, most data refer to terrestrial birds (Sauer et al. 2000)
- 5) Scientific research documents
- 6) Anecdotal evidence

Most of the data are qualitative, not quantitative in nature. Usually, bird counts give an estimate of relative abundance per area and not of absolute bird density. Thus, it is difficult to compare relative abundances across different areas, observers and years. Furthermore, most available data are not long-term (i.e. only the last 20-30 years), and only a few data points reach into the early 20th century. Thus, historical evidence is almost entirely anecdotal.

Moreover, most data are not taken regularly and are inconsistent in terms of their aerial, seasonal and yearly distribution. For example, CWS Coastal Survey data vary in terms of the spatial (number of

survey blocks investigated, number of counts per block) and temporal (time of the year, number of counts per year, number of years) distribution of bird counts. Intensive investigations were carried out in the 1970's but not before or after. These data were used to map the overall distribution patterns of seabirds, waterfowl, shorebirds and raptors in the area throughout the year (see Fig. 2.5.1). Results were compared and confirmed with anecdotal and scientific evidence. CWS Seabird Colony data are more consistent since species utilize same islands / colonies over time. Trends for some species were visible over time. These trends were compared with results from the North American Breeding Bird Survey for New Brunswick and with anecdotal and scientific evidence to confirm local trends. For trends in wintering birds, results from Christmas Bird Counts were used from two stations: Blacks Harbour and Grand Manan. Data are available for the last 20 years with some data points referring to 1938. Again, results were compared with anecdotal and scientific evidence to confirm local trends.

Table 2.5.2. Status of species at risk as listed by the Committee on the Status of Endangered Wildlife in Canada in November 2000 (COSEWIC 2000, <http://www.cosewic.gc.ca>) and recent trends if available. CBC = Christmas Bird Counts, SCS = Seabird Colony Survey.

Species	Status	Year	Recent Trend	Reference
Great auk <i>Pinguinus impennis</i>	Extinct	1844	--	
Labrador duck <i>Camptorhynchus labradorius</i>	Extinct	1875	--	
Passenger pigeon <i>Ectopistes migratorius</i>	Extinct	1914	--	
Eskimo Curlew	Endangered	1978	-?-	
Harlequin duck	Endangered	1990	increasing	CBC
Piping plover	Threatened	1978		
	Endangered	1985	-?-	
Roseate tern	Threatened	1986		
	Endangered	1999	increasing	SCS
Peregrine falcon, (f. <i>anatum</i>)	Endangered	1978		
	Threatened	1999	increasing	SCS
Barrow's goldeneye	Special Concern	-?-	-?-	

Table 2.5.3. Results from the North American Breeding Bird Survey (BBS) for New Brunswick for 1966-1999 (Sauer et al. 2000). Separate trend analyses were performed for 1966-1979 and 1980-1999. Birds are grouped into S = Seabirds, Sh = Shorebirds, W = Waterfowl, and R = Raptors. Significant ($P < 0.05$) trends are printed bold and are only regarded as significant when $N > 5$.

Species	1966-1999			1966-1979			1980-1999		
	Trend	P	N	Trend	P	N	Trend	P	N
S Black-crown. night heron	-32.2	0.26	3	-29.4	0.51	2	--	--	--
S Black tern	-19.1	0.19	2	-14.7	0.14	2	--	--	--
S Common tern	-7.4	0.29	8	-0.7	0.95	7	5.6	0.54	4
S Herring gull	-4.6	0.00	18	-7.1	0.01	11	-3.7	0.01	15
S Great black-backed gull	1.6	0.47	15	1.1	0.77	9	1.5	0.82	14
S Common loon	2.5	0.30	18	-0.1	0.99	13	-1.0	0.75	15
S Pied-billed grebe	4.1	0.57	3	4.7	0.65	3	-0.7	0.96	2
S Great blue heron	4.2	0.06	17	4.7	0.35	12	5.8	0.26	13
S Ring-billed gull	7.8	0.32	8	--	--	--	1.5	0.94	8
S Double-crest. cormorant	9.9	0.01	13	17.4	0.17	6	13.5	0.15	10
Sh American woodcock	-13.0	0.05	8	9.1	0.82	5	-15.2	0.40	3
Sh Common snipe	-2.5	0.00	30	1.2	0.56	24	-4.8	0.00	23
Sh Killdeer	0.2	0.89	28	5.4	0.09	23	-4.0	0.13	24
Sh Spotted sandpiper	0.8	0.72	27	7.7	0.14	21	-5.0	0.20	16
W Red-breasted merganser	-17.3	0.12	3	-11.8	0.26	2	--	--	--
W Blue-winged teal	-3.4	0.19	4	3.4	0.02	3	1.0	0.82	3
W Common goldeneye	-0.6	0.90	5	-3.6	0.93	2	2.9	0.39	4
W Common Merganser	-0.3	0.98	13	-27.5	0.06	5	16.0	0.14	9
W American black duck	0.8	0.75	23	3.2	0.00	14	1.6	0.52	18
W Green-winged teal	0.8	0.59	4	38.0	0.52	4	-7.9	0.82	2
W American wigeon	6.8	0.06	5	6.1	0.35	2	4.6	0.25	4
W Wood duck	7.6	0.10	3	7.7	0.68	2	9.4	0.04	3
W Ring-necked duck	8.0	0.68	3	-7.9	0.57	3	19.9	0.47	2
W Canada goose	25.1	0.17	3	--	--	--	--	--	--
W Mallard	32.5	0.03	3	--	--	--	35.0	0.05	3
R Osprey	8.3	0.00	14	27.5	0.05	7	2.4	0.59	12
R Bald eagle	18.9	0.40	2	--	--	--	34.7	0.09	2

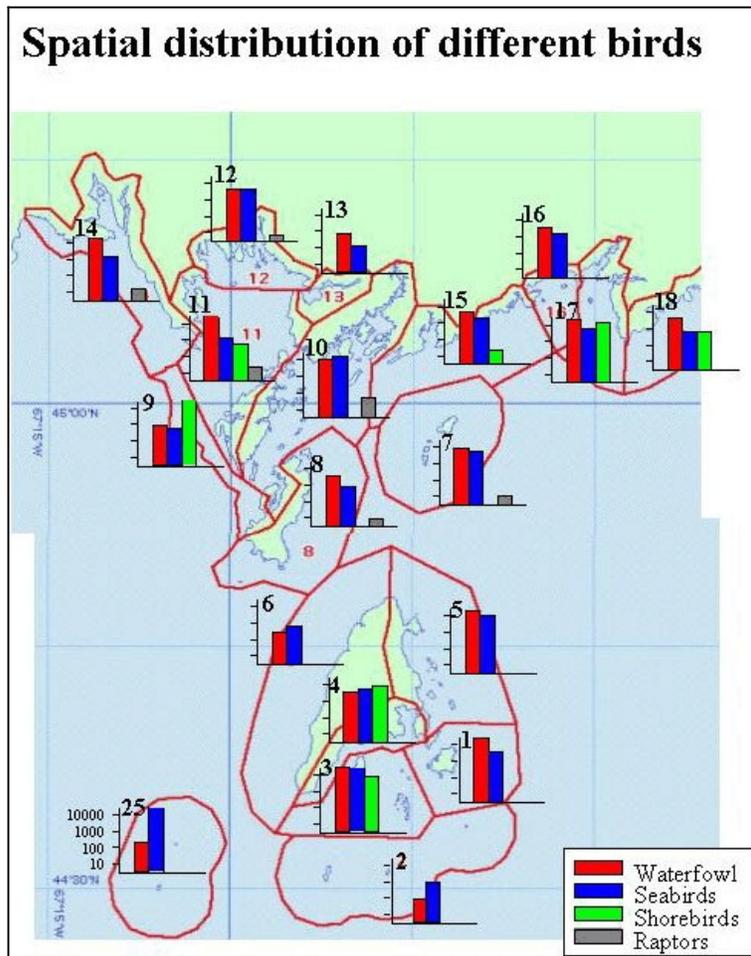


Fig. 2.5.1. Spatial distribution of waterfowl, seabirds, shorebirds and raptors throughout the year counted in the period from 1967 to 1996 (CWS Coastal Survey data, Lock et al. 1994). Data are on a logarithmic scale.

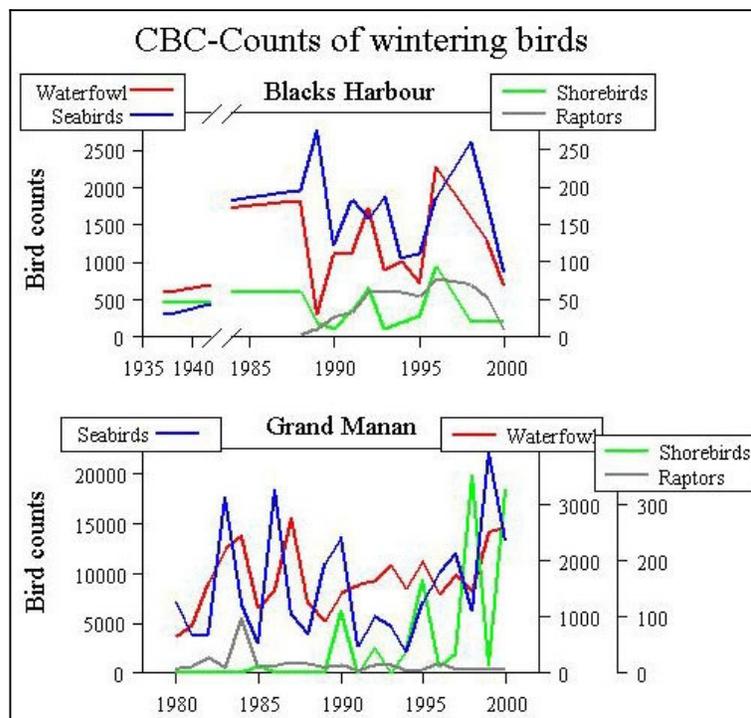


Fig. 2.5.2. Results of the Christmas Bird Counts on wintering birds for Blacks Harbour and Grand Manan summarized for species groups. Note, that shorebirds are mainly purple sandpipers, and raptors are mainly bald eagle.

2.5.4.1. Waterfowl

The primary areas of importance to waterfowl are the east coast of Grand Manan, Passamaquoddy Bay, the approaches and passages into Passamaquoddy Bay and L'Etang Inlet, and Maces Bay (Fig. 2.5.1). Waterfowl utilization of these areas partly varies with species and season. In fall (October – December) and winter (January – March), areas of highest importance to waterfowl include the east coast of Grand Manan (block 3, 4, 5), outer Campobello (8), Passamaquoddy Bay and St. Croix estuary (11-14), and the mainland coast towards Pt. Lepreau (15-18) (Lock et al. 1994).

Especially important for wintering of the endangered Harlequin duck are The Wolves (7) with approximately 50 birds (Lock et al. 1994) and White Head Island with 25 birds (block 1, F. Huettmann, *personal communication*). This is the only area in Atlantic Canada with appreciable numbers of this endangered bird (Table 2.5.2, CWS 1979), although up to 500 are found in nearby Gulf of Maine (Lock et al. 1994).

High fall and winter populations of American Black ducks concentrate in the Bay of Fundy (CWS 1979, Hicklin 1996), and the Quoddy Region is the only area in the bay where Barrow's goldeneye can be found, a 'species of special concern' (Table 2.5.2, CWS 1979, COSEWIC 2000). The Quoddy Region also hosts the most important concentrations of Bufflehead and White-winged scoters in eastern Canada (CWS 1979).

In spring (Apr-Jun), The Wolves (7) and the area outside and at the entrance to Passamaquoddy Bay (10) are of high importance to waterfowl (Lock et al. 1994). In summer, the east coast of Grand Manan (1, 3, 5), the inner Passamaquoddy Bay around Bocabec Bay and Digdeguash (12), and Maces Bay (16, 17) are important.

Although not many data are available, it can be assumed that most waterfowl populations have increased since protective laws were introduced in the 1920's (Fig. 2.5.2, Christie 1979). In recent years, most species have not shown any abundance trends (Fig. 2.5.2), but some are stable and others are increasing (Table 2.5.4). The recent increase in numbers of the endangered Harlequin duck is a hopeful sign (Table 2.5.4).

Table 2.5.4. Summary of waterfowl with observed clear long-term (left) or recent (right) trends from CBC (Christmas Bird Counts), SCS (Seabird Colony Survey, CWS), and BBS data (North American Breeding Bird Survey, trend results for N.B. that include $P < 0.05$ and $N > 5$, Table 2.5.3).

	Long-term (1920/38-1970)	Recent (1966/70-2000)
Declining	Oldsquaw (CBC) Common goldeneye (CBC)	Brant (CBC) Common goldeneye (CBC)
No Trend / Stable	Red-breasted Merganser (CBC)	Common eider (CBC, Mawhinney et al. 1999) Bufflehead (CBC) White-winged scoter (CBC) Mallard (CBC)
Increasing	Common eider (SCS) American black duck (CBC)	Harlequin duck (CBC) American black duck (BBS, CBC) Black scoter (CBC) Surf scoter (CBC) American wigeon (BBS)

Notes on single species

Common eider *Somateria mollissima*

Great numbers of Common eiders nested around Bay of Fundy in mid 1800s. They gradually decreased in number because of hunting and egg and down collection until by 1923, only a few were left on Grand Manan. Since then, the Kent Island sanctuary was established and hunting regulations imposed. The numbers of breeding birds around Grand Manan increased to 2000 in 1940s and further to 4000 in 1969 (Table 2.5.4, Squires 1976, Christie 1979, SCS). The SCS data indicated a decline of breeding Common eiders in the late 1980s and 1990s, but data from Mahwinney et al. (1999) showed a stable breeding population from 1987-1998. Today, most colonies are around Grand Manan (2763-5237 pairs), Passamaquoddy Bay including Campobello / Deer Island (3375), and The Wolves (1342) (Lock et al. 1994, Hicklin 1996, Mawhinney et al. 1999). Although adult birds may have remained stable, the numbers of ducklings decreased during 1987-1998, due to increasing gull predation (Mawhinney et al. 1999, Hamilton 2000a), and commercial rockweed harvesting that affects this important nursing habitat (Hamilton 2000b).

Harlequin duck *Histrionicus histrionicus*.

In 1873, Herrick (in Goudie 1989) considered the Harlequin duck as common in winter in the Grand Manan archipelago. Goudie (1989) estimated the former population of Harlequin ducks in eastern North America to have been 5000-10000 birds. It was less than 1000 in the 1980s. In 1990, the Harlequin duck was listed as endangered by COSEWIC (Table 2.5.3). Hunting, more than any other factor, was linked to the decline of Harlequin ducks, because this species has been noted for its relative tameness compared to other sea ducks (Philips 1925 and Palmer 1949, 1976 in Goudie 1989). In recent years, about 500 birds have wintered on islands near the coast of Maine and another 100 in southwest New Brunswick (40-45 on The Wolves, 25 at White Head Island, and some at Point Lepreau, Lock et al. 1994, F. Huettmann *personal communication*), the only appreciable number of this endangered duck in Atlantic Canada (CWS 1979). Today, Harlequin ducks can only be found at a handful sites, i.e. very inaccessible headlands, offshore skerries or park reserves, all typical wildlife refugia (Goudie 1989).

Labrador duck *Camptorhynchus labradorius*

This duck became extinct so early (1875, Table 2.5.2) that little is known of its life history. Squires (1976) noted that Mr. Boardman reported this species as common in the Bay of Fundy in 1845, but that he might have exaggerated its abundance. The last record in New Brunswick was in 1871 (Squires 1976).

2.5.4.2. Seabirds

The highest concentrations of seabirds (> 10000) have been observed on Machias Seal Island (CWS survey block 25) south of Grand Manan (3), and within the passages and entrances to Passamaquoddy Bay and L'Etang (10) (Fig. 2.5.1). Moderate numbers (1000-10000) of seabirds are found in the eastern Grand Manan archipelago (1, 4, 5), in Passamaquoddy Bay and St. Croix estuary (11, 12, 14) and along the mainland coast from L'Etang to Pt. Lepreau (15, 17). In all other blocks, seabirds occur in smaller numbers (100-1000).

For many breeding seabirds, such as Atlantic puffins, Razorbill auks, Arctic and Common terns, Northern gannets, Common murrelets, and Leach's storm-petrels, the Quoddy Region is their most important or only habitat in New Brunswick, the Bay of Fundy or Eastern Canada (CWS 1979). There are also important concentrations of migrating birds in the area, such as Bonaparte's gulls (CWS 1979,

Gaskin & Smith 1979, Braune & Gaskin 1982a, Huettmann et al. 2000), non-breeding Arctic and Common terns (Braune & Gaskin 1982a), and Greater and Sooty shearwaters (CWS 1979). In winter, the largest concentrations of Herring gulls in the Maritimes (CWS 1979), and the only concentrations of wintering Razorbill auks (approximately 50,000), Dovekies, Common murre and Black-legged kittiwakes south of Newfoundland (CWS 1979, Huettmann & Diamond 2000) are found in the area. Furthermore, New Brunswick's only wintering concentrations of Great cormorants and Common loons are found in the study area (CWS 1979).

Since protective laws were introduced in the 1920s, clear long-term increases can be noted for larger gulls such as Herring and Great black-backed gulls, and Double-crested cormorants (Table 2.5.1, 2.5.5, Christie 1979). Although recent trends were suggested negative for Herring gulls, many seabirds appear to have increased in recent decades (Table 2.5.5). Especially hopeful is the re-establishment of breeding pairs of Common murre and Northern gannets (one pair) in the 1980s and 1990s off Deer Island and on Machias Seal Island (SCS, Lock et al. 1994, J. Chardine, *personal communication*), and a recent increase in breeding pairs of the endangered Roseate tern (SCS). Terns and alcids showed increasing breeding populations in recent decades at least on Machias Seal Island, and Black-legged kittiwakes showed an increase in the 1980s but declined again in the 1990s (SCS, Lock et al. 1994).

Table 2.5.5. Summary of seabirds with observed clear long-term (left) or recent (right) trends from the CBC (Christmas Bird Counts), SCS (Seabird Colony Survey, CWS), and BBS (North American Breeding Bird Survey, trend results for N.B. that include $P < 0.05$ and $N > 5$, Table 2.5.3).

	Long-term (1920/38-1970)	Recent (1966/70-2000)
Declining	Black guillemot (CBC)	Herring gull (BBS, SCS, CBC) Dovekie (CBC)
No Trend / Stable		Great blue heron (BBS, SCS) Black-crowned night heron (SCS) Great cormorant (CBC) Red-necked grebe (CBC) Black-legged kittiwake (CBC, SCS)
Increasing	Herring gull (SCS, CBC) Great black-backed gull (SCS, CBC) Double-crested cormorant (SCS) Common loon (CBC)	Great black-backed gull (SCS, CBC) Double-crested cormorant (BBS, SCS) Black guillemot (SCS, CBC) Common murre (SCS, CBC) Razorbill (SCS, CBC) Atlantic puffin (SCS) Common tern (SCS) Roseate tern (SCS) Northern gannet (SCS, CBC) Common loon (CBC) Horned grebe (CBC) Ring-billed gull (CBC) Bonaparte's gull (CBC) Iceland gull (CBC)

Notes on single species

Great auk *Pinguinus impennis*

The only evidence that the Great auk used to be found in New Brunswick is the bones found in the shell heaps left by prehistoric Indians (Squires 1976, Bishop & black 1988, Murphy & black 1996). Because its bone remains were found frequently, Squires (1976) suggested that this species might have been quite common in the outer Fundy. The last known Great auk was killed in 1844 on an island near Iceland, making this bird is extinct (Table 2.5.2). In historic times, the Great auk bred on both sides of the North Atlantic. In North America, it was found on islands near Newfoundland where it was slaughtered by the thousands by fisherman (Squires 1976).

2.5.4.3. Shorebirds

Regarding the spatial distribution of migratory shorebirds in the area, high numbers are found on the south coast of Grand Manan (block 3, 4, Fig. 2.5.1), near St. Andrews (block 11), and in Maces Bay (block 17). Almost 75 percent of these migratory shorebirds are Semi-palmated sandpipers (Lock et al. 1994). The other 25 percent include Least sandpipers, Semi-palmated plovers, Short-billed dowitchers, and others (Lock et al. 1994). Although no local trend data are available, Morrison et al. (1994, 1997) reported population trends for the Maritimes using data from the Maritimes Shorebird Survey from 1974-1991, in which sites on Grand Manan and Passamaquoddy region were included. Results suggested clear declining trends for the Semi-palmated sandpiper and Least sandpiper. Weak declines occurred in Black-bellied plover, Red knot, and Short-billed dowitcher (Morrison et al. 1997). Decreasing trends were also noted for breeding Common snipe and American woodcock (BBS, Table 2.5.3).

A slight increasing trend was suggested for the Whimbrel (Morrison et al. 1997). Other shorebirds, e.g. the Lesser golden plover and the Willet, Christie (1979) noted a slow recovery, while the situation of Eskimo curlew and Piping plover were regarded as more critical (Table 2.5.2). For the Purple sandpiper, the Quoddy Region is the most important wintering area in New Brunswick (CWS 1979). Long-term data show a slight increase in abundance since 1938 in Blacks Harbour and varying numbers in recent years (Fig. 2.5.2). However, numbers of Purple sandpipers wintering on Grand Manan appear to be increasing (Fig. 2.5.2).

Overall, shorebird populations appear to have recovered and increased over the long term, but in recent decades trends indicate rather stable or declining populations (Table 2.5.6). Morrison et al. (1997) mentioned that other North American survey programs have also noted recent declines in shorebird populations.

Notes on single species

Red-necked (or northern) phalarope

Concentrations of Red-necked phalaropes in Head Harbour Passage were the largest known in eastern North America (CWS 1979) and represented a significant fraction of the overall North American population (Mercier & Gaskin 1985). This species was the predominant phalarope species in the Quoddy Region, appearing in late June for the fall migration to the South. They breed circumpolar in the Arctic and winter at sea off South America or South Africa (Brown & Gaskin 1988). The total population traveling through the Bay of Fundy was from 100,000 – 1,000,000 birds during the 2.5 months staging period (Mercier & Gaskin 1985), and local concentrations could be as high as 5,000 – 20,000 birds per

km² (Mercier & Gaskin 1985). While in Head Harbour Passage, Red-necked phalaropes fed mainly on copepods (88.6 percent *Calanus finmarchicus*, Mercier & Gaskin 1985) and small euphausiids (Gaskin & Smith 1979, Mercier & Gaskin 1985). However, a recent abandonment of this traditional feeding place was noted (Lock et al. 1994), starting in 1986 when a major decline in numbers was observed. By 1990 the species was essentially absent (Duncan 1996). It has been suggested that greatly reduced numbers of copepods might have caused the decline, but a similar abandonment of Red phalaropes near Brier Island during the late 1980s was not correlated with reduced plankton abundance (Brown 1991 cited in Duncan 1996). Shifts of migration routes or wintering areas may be other possible reasons.

Table 2.5.6. Summary of shorebirds with observed clear long-term (left) or recent (right) trends from CBC (Christmas Bird Counts), SCS (Seabird Colony Survey, CWS), and BBS (North American Breeding Bird Survey, trend results for N.B. that include $P < 0.05$ and $N > 5$, Table 2.5.3), and MSS (Maritimes Shorebird Survey) for the entire Maritimes (Morrison et al. 1997).

Long-term (1920/38-1970)		Recent (1966/70-2000)
Declining		Semi-palmated sandpiper (MSS) Least sandpiper (MSS) Black-bellied plover (MSS) Red knot (MSS) Short-billed dowitcher (MSS) American woodcock (BBS) Common snipe (BBS)
No Trend / Stable		Spotted sandpiper (BBS) Killdeer (BBS)
Increasing	Purple sandpiper (CBC)	Purple sandpiper (CBC, SCS) Whimbrel (MSS)

2.5.4.4. Raptors

Bald eagles and Ospreys are important fish-eating raptors, while the Peregrine falcon preys on ducks, shorebirds and seabirds (NGS 1987). Between 1967-1996, the abundance of raptors was highest in block 10, followed by block 11, 14, 7 and 15 (Fig. 2.5.1). Data over time are rare. The SCS and BBS indicate an increase in Osprey in the Quoddy Region during the 1960s and 1970s, but no clear trend is available for 1980s and 1990s (Table 2.5.3). Bald eagle counts in winter indicate an increase in the early 1990s at Blacks Harbour (CBC) followed by a decrease in the late 1990s. No such trend could be observed at Grand Manan (CBC). The last breeding record for the Peregrine falcon in New Brunswick was in 1948 (Christie 1979), but in the last six years, successful re-introductions of breeding pairs has been accomplished in Fundy National Park (Park Information). In 1999, one pair of Peregrine falcons started breeding again in the study area on Seven Day's Work, a large cliff face on Grand Manan (S. Gerriets, *personal communication*). Overall, since protective laws were introduced in the 1960s and 1970s, a slow increase of raptors may have taken place. A contributing factor to the increase may be the reduction of pesticides (e.g. DDT) in the environment, which threatens reproductive success in raptors (see above).

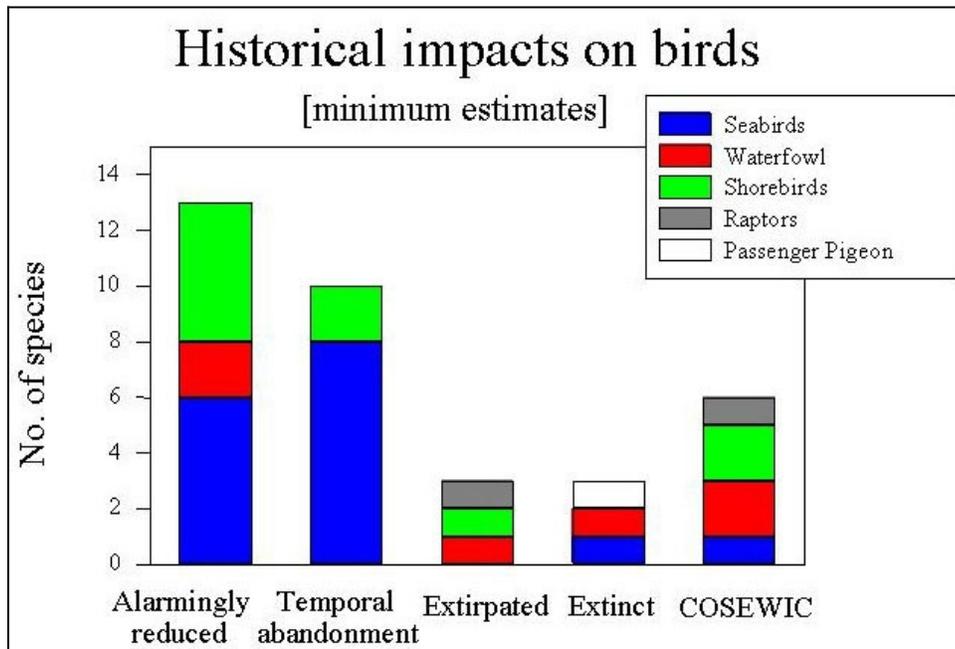


Fig. 2.5.3. Documented historical impacts on marine birds in the study area and today's listings under COSEWIC. Only species which were named in the literature were included, thus results are minimum estimates.

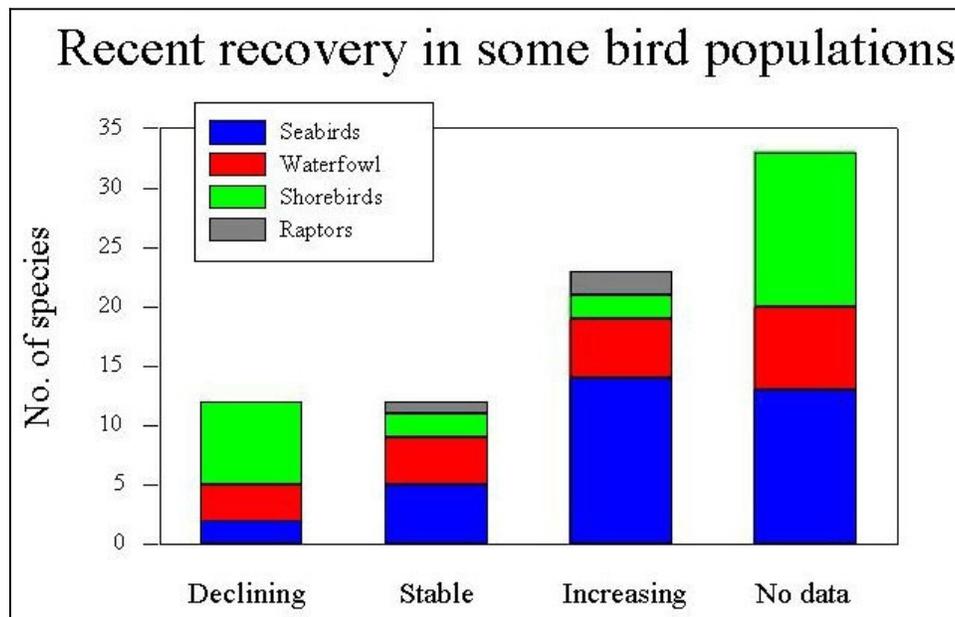


Fig. 2.5.4. Waterfowl seem to have increased over the long term but show no clear further recovery in recent decades, and shorebirds show rather declining trends in recent decades.

2.5.5. Trends in bird populations - conclusions

Historically, all species groups have been strongly affected by human activities in one way or another, notably over-hunting and habitat alteration and degradation. This has caused severe population declines leading to extinction or extirpation of some species, or the temporal abandonment of traditional colonies (Fig. 2.5.3). Today, some species are still struggling at low population levels and are listed by COSEWIC (Table 2.5.2).

Since protective laws were introduced in the 1920s, however, many species have recovered to some extent. Those that took advantage out of human activities (e.g. scavenging gulls) recovered rapidly. Others recovered more slowly in small colonies on remote islands less disturbed by human activities (Machias Seal Island, Kent Island). Very recently, some seabirds re-established breeding colonies in the area after abandonment for over 50-100 years (e.g. Northern gannet, Common murre). This may indicate how long recovery may take for such long-lived organisms after strong human-induced disturbance and overexploitation.

Recent trends indicate that especially seabirds are increasing (Fig. 2.5.4), which may indicate that recovery of seabird populations can take place when humans provide undisturbed, protected habitats that fulfill the species-specific needs.

Waterfowl seem to have increased over the long term but show no clear further recovery in recent decades, and shorebirds show rather declining trends in recent decades (Fig. 2.5.4). and shorebird species are more dependent on shorelines, which are closer to human settlements and activities for nesting, feeding, staging and nursing than are seabirds (Fig. 2.5.1). Thus, increasing trends in seabirds on more remote islands may be not reflected in waterfowl and shorebirds because the latter are more exposed to human impacts. The recent expansion of the finfish aquaculture operations into more remote island areas, however, may undermine these islands' role as seabird refuges.