

Decline in Breeding of the Great Black-backed Gull, *Larus marinus*, and the Herring Gull, *L. argentatus*, on Boot Island, Nova Scotia, 1986 to 2010

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For over 50 years, Boot Island, Nova Scotia, has supported a significant mixed bird colony: Great Black-backed Gull (*Larus marinus*), Herring Gull (*L. argentatus*), Great Blue Heron (*Ardea herodias*), and Double-crested Cormorant (*Phalacrocorax auritus*). In 2002, the largest Great Black-backed Gull colony in Canada was located there. Over the last quarter century, the Herring Gull colony has shown a dramatic and near-linear decrease from 727 nests in 1986 to 67 in 2000; in 2010, only two nests remained. The number of Great Black-backed Gull nests has also declined by 44%, from 1467 nests in 1992 to 819 in 2010. These reductions may be partly attributed to factors external to the colony, such as changes in regional fisheries and better landfill management. However, a more immediate problem may be nest predation and disturbance by American Mink (*Neovison vison*), Raccoon (*Procyon lotor*), Coyote (*Canis latrans*), and Bald Eagle (*Haliaeetus leucocephalus*).

Key Words: Great Black-backed Gull; *Larus marinus*; Herring Gull; *Larus argentatus*; Boot Island; National Wildlife Area; Nova Scotia; nesting; population decline

Introduction

Following the indiscriminate slaughter of many seabirds in the late 19th and early 20th century, often for the millinery trade, Great Black-backed and Herring Gulls recovered with a dramatic increase in numbers, resulting in great overlap in their breeding ranges (Drury 1973). In the first half of the 20th century, Herring Gulls were by far the more numerous (Drury 1973). However, after reaching a peak in the 1970s and 1980s, their numbers along the east coast of North America started to decline, while Great Black-backed Gull numbers continued to increase (Brown *et al.* 2001 in Rome and Ellis 2004; Shoals Marine Laboratory 2010*). Currently, in eastern Canada, the Great Black-backed Gull is deemed “not currently at risk” while Herring Gull populations are of “moderate” concern as there is an apparent population decline (Milko *et al.* 2003*).

These colonial birds require remote, disturbance-free habitat in which to nest. The Great Black-backed Gull, *Larus marinus*, and the Herring Gull, *L. argentatus*, are ground-nesting birds that are highly susceptible to mammalian predation and, thus, seek out isolated breeding locations (Pierotti and Good 1994). Such colonies are frequently situated on remote islands where monitoring by counting the number of nests is often difficult because of poor and limited site access and a narrow survey window.

Surveys of Great Black-backed and Herring Gull colonies are conducted regularly in eastern Canada. However, when time and resources are limited, a trade-off is made between monitoring a few colonies intensively and conducting infrequent surveys of many col-

onies over a wide geographic area. Broad-scale surveys, frequently conducted from the air, predominate as the desired method of monitoring populations at a regional scale. However, aerial counts are not as accurate as ground surveys (Drury 1973; Boyne and Hudson 2002*) and are often of limited value in tracking population trends of individual colonies.

Gull colonies in Boot Island National Wildlife Area (Kings County, Nova Scotia) present a unique monitoring opportunity for eastern Canada because biennial surveys of colonial nesting birds have been undertaken as part of the National Wildlife Area’s management regime since 1984. In this article, we assess changes in the size of both Great Black-backed and Herring Gull colonies from 1986 to 2010 and discuss possible factors affecting the multiyear decline in both species.

Study Area

Boot Island National Wildlife Area is located in the southern bight of Minas Basin at the mouth of the Gaspereau River, 8 km northeast of Wolfville, Kings County, Nova Scotia (45°08'N, 64°16'W). The 107-ha wildlife area consists of approximately 91 ha of salt marsh and 16 ha of uplands (Figure 1). The uplands comprise the 15.5-ha main island (2.0 ha forested and 13.5 ha of open habitat) as well as a 0.5-ha treeless and much smaller “Cyril’s Island” (Little Boot Island). The upland portion of Boot Island slopes gently upward from the salt marsh in a northeast direction, such that the seaward face consists of an actively eroding 6-m high mud and sandstone cliff. The small forested area is dominated by a dense stand of dead and dying White

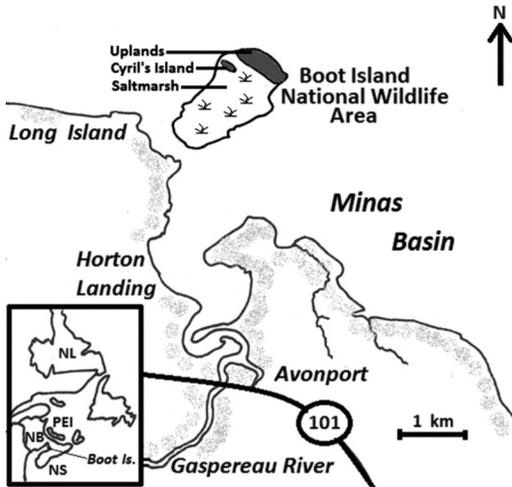


FIGURE 1. Location of Boot Island National Wildlife Area, Kings County, Nova Scotia.

Spruce (*Picea glauca*) with scattered Red Maple (*Acer rubrum*), Trembling Aspen (*Populus tremuloides*), and Balsam Fir (*Abies balsamea*). Decay of the forest has been exacerbated by the deleterious effects of tree-nesting Great Blue Herons (*Ardea herodias*) (see MacKinnon and Kennedy 2006*).

The area of open field habitat, where most Great Black-backed and Herring Gull nests are located, is dominated by two species of wild mustard: Wild Radish (*Raphanus raphanistrum*) and Hairypod Hedgemustard (*Sisymbrium officinale*). The remaining area is composed of open field and rough cover consisting of a nearly impenetrable thicket of Virginia Rose (*Rosa virginiana*), American Red Raspberry (*Rubus idaeus*) and Northern Bayberry (*Myrica pensylvanica*) (Newell *et al.* 2006*).

Historically, Boot Island supported large colonies of Great Black-backed and Herring Gulls. The island also supports a large colony of Great Blue Herons and Double-crested Cormorants (*Phalacrocorax auritus*), and once supported a significant winter roost of American Crows (*Corvus brachyrhynchos*) (Milton 1983). However, around 1991 the crows relocated 19.5 km to the southwest to the town of Kentville on the mainland. The inter-tidal mudflats in the vicinity of the island are recognized as a RAMSAR site (a wetland of international importance) and support a diversity of migrant shorebirds (Elliot 1977; Hicklin 1981, 1984; Mawhinney 1991*; Gilliland 1992). These flats also sustain a commercial bait (Bloodworm, *Glycera dibranchiata*) industry (Klawe and Dickie 1957*).

Until the late 1800s, Boot Island was connected to the mainland and it has a long history of human use (Mitcham 1986). The island was farmed intensively, and an extensive system of dykes and ditches draining the adjacent salt marshes existed until agricultural activities ceased in approximately the 1930s.

Over many decades, biologists and naturalists have visited Boot Island and reported wildlife observations. The late Cyril Coldwell, curator of Acadia University's ornithology collection, provided most colonial bird observations throughout the 1960s. The first detailed survey of colonial birds on Boot Island was carried out by Barkhouse (1976*), who also summarized past observations, reporting that gulls started nesting on the island around 1948 followed shortly after by breeding Great Blue Herons. Double-crested Cormorants were first reported nesting in 1967.

Methods

Between 1976 and 2010, 14 surveys of gull nests were completed, recording both occupied and unoccupied nests. All surveys were centred at the peak or the end of the Great Black-backed Gull's egg-laying period in mid-May (survey dates ranged from 8 to 19 May, average 13 May). Although Herring Gulls lay slightly later than Great Black-backed Gulls, full (three-egg) clutches of the former were frequently encountered, and thus we believe that this single survey window adequately captured the number of nests occupied by both species. Slight variations in survey date were due to weather and travel conditions, as the tidal waters between Boot Island and the mainland are extremely hazardous. No surveys were conducted during cold or wet conditions (see Diamond 2001*).

Following the census method described by Barkhouse (1976*), surveys were carried out by walking a series of parallel transects across the narrowest width of the colony. Observers walked abreast and within close proximity to each other. The outermost observers temporarily marked the flanks of each transect with red flagging tape. On completion of a transect, the group wheeled around in unison so that on the return transect, the person who had been on the outermost flank followed his or her previously marked line. One person in the centre, usually the crew leader, was the recorder. The crew leader set the transect width, based on observer visibility and nesting density and recorded and confirmed observations relayed from the rest of the team. Observations reported orally by crew members were repeated by the recorder for confirmation. The crew leader also kept track of crew observations visually to prevent duplication or missed nests. All movement within the colony was kept to a minimum. To reduce disturbance, hand signals were often used to relay instructions, such as change direction, stop, proceed, etc.

Contents of Great Black-backed and Herring Gull nests (empty, number of eggs and/or number of chicks) were recorded. Any structure more elaborate than a simple scrape with some built-up edge was deemed a nest (Diamond 2001*). To distinguish between Great Black-backed and Herring Gull eggs, the following criteria were used:

Locations of grouped Herring Gulls within the larger colony of Great Black-backed Gulls were noted.

The approximate position of individual Herring Gulls on nests in relation to adjacent features (bush, rock, etc.) was visually tracked.

The sizes of all eggs, in each nest, were visually attributed to species; Herring Gull eggs are about 19% smaller than Great Black-backed Gull eggs (Bent 1963*), although there is some variation in size between regions (see Pierotti and Good 1994; Good 1998). The collective size of all eggs in a specific nest, along with the above supporting criteria, were used to identify it as either Great Black-backed or Herring Gull.

A survey typically required 4–6 hours to complete. To minimize further disturbance within the gull colony and adjacent Great Blue Heron and Double-crested Cormorant colonies, nests were not marked to determine a correction factor (e.g., Lincoln index).

To test whether the population decline of gulls was significant, we used a linear regression analysis. The regression and regression equations were calculated using the statistical package within Microsoft Excel while t and P values were calculated as per Scheffler (1980); applying the two-tailed test.

Results and Discussion

Herring Gull nests were first recorded in significant numbers in 1976 (712 nests; Figure 2). The number of nests peaked in 1986 (727 nests), but by 2010, only 2

nests were recorded in the survey. The near-linear decline in the number of Herring Gull nests on Boot Island from 1986 to 2000 suggests a constant pressure on these birds ($R^2 = 0.99$, $y = -46.394x + 92\,857$, $n = 7$ surveys, $t = 25.7$, $P < 0.01$) (Figure 2).

The number of Great Black-backed Gull nests were also first recorded in significant numbers in 1976 ($N = 1005$). The number of nests peaked in 1992 ($N = 1467$), and by 2010, the number of nests had decreased by 44% to 819. The decline of Great Black-backed Gull nests was significant but a more variable decline from 1992 to 2010 ($R^2 = 0.82$, $y = -31.434x + 64\,010$, $n = 9$ surveys, $t = 5.74$, $P < 0.01$) (Figure 2).

Although the survey window remained the same between 1976 and 2010, the ratio of occupied to unoccupied Great Black-backed Gull nests fell from a high of 22.3:1 in 1986 to just 2.3:1 in 2010 (Figure 3). While the Great Black-backed Gull colony was declining, there was a noted increase in the proportion of empty nests. This could be a result of young and inexperienced breeders nesting later, although we believe that the increase in empty nests reflects an increase in predation on eggs and/or chicks. For Herring Gulls, the ratio of occupied to empty nests ranged from 3.7:1 in 1986 to an average of 4.1:1 from 1996 to 2000 (Figure 4). The observed differences in the ratios may reflect both the timing of heavier predation and an artefact

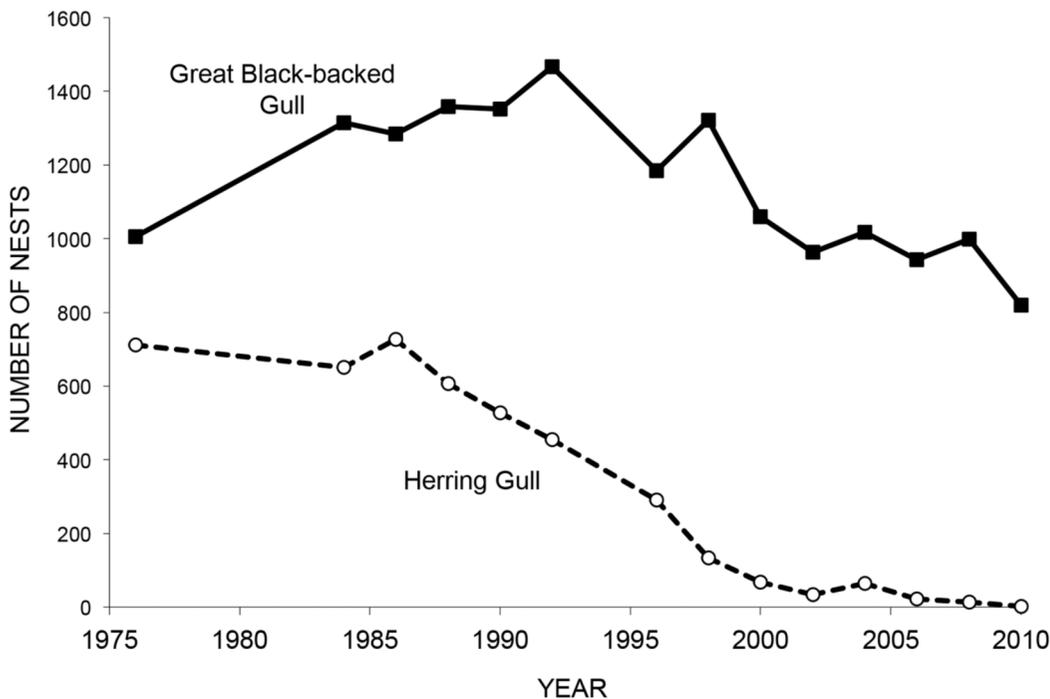


FIGURE 2. Number of nests (occupied and unoccupied) of Great Black-backed Gulls (*Larus marinus*) and Herring Gulls (*L. argentatus*) found at Boot Island National Wildlife Area, Nova Scotia, 1976 to 2010.

of the survey window, as Great Black-backed Gulls begin egg laying earlier than Herring Gulls. It is noteworthy that there was an increase in the ratio of occupied to empty Great Black-backed Gull nests from 2006 to 2010 when the Herring Gull colony had been reduced to fewer than 25 nests (Figures 3 and 4). During this same period, Coyote began to visit the island and predation by this species became a more obvious and regular event (MacKinnon *et al.* 2007).

It is well documented that Great Black-backed Gulls are more aggressive and may out-compete Herring Gulls as well as preying on young birds (Threlfall 1968; Rome and Ellis 2004; Cotton 2009). This may at least partly explain the earlier onset of the Herring Gull decline. However, by the early 1990s, both species were in decline and other factors must be considered.

During this period of decline in both gull species and the increasing proportion of empty Great Black-backed Gull nests, the breeding numbers in the adjacent Great Blue Heron and Double-crested Cormorant colonies remained relatively constant. From 1984 to 2010, Great Blue Herons and Double-crested Cormorants averaged 53 nests (range 38–75, $n = 13$ surveys) and 232 nests (range 147–351, $n = 13$ surveys), respectively (MacKinnon *et al.* 2010*). No obvious overall change or trend in colony size was observed. The factors influencing the gull decline are apparently

not affecting the health of the adjacent tree-nesting colonial species.

It is worth noting that, based on 2002 aerial survey data (753 pairs), the Great Black-backed Gull colony on Boot Island, Nova Scotia, was the largest in Canada (Cotter *et al.* 2012*). Furthermore, if Herring Gulls were deserting Boot Island for other locations, currently the closest large Herring Gull colony is situated in an inland bog 195 km to the southwest on Briar Island, Nova Scotia. (Environment Canada 2008*; Cotter *et al.* 2012*).

Food Availability

Human refuse and landfills

Changes in the handling of human refuse, such as the closure or reduction of landfills, have been cited as one reason for decreases in gull populations (Drury 1973; Shoals Marine Laboratory 2010*). In Nova Scotia, a solid waste management strategy was released in 1995 (Friesen 2000), although organic garbage was not banned from the province's landfill sites until 30 November 1998 (Speed 2000*). By this time, the Herring Gull colony on Boot Island had already collapsed and Great Black-backed Gull numbers were in decline. Although competition for limited food resources may have been partly responsible for the changes in the colony, we do not have any direct evidence that the changes in management of human refuse in the vicinity

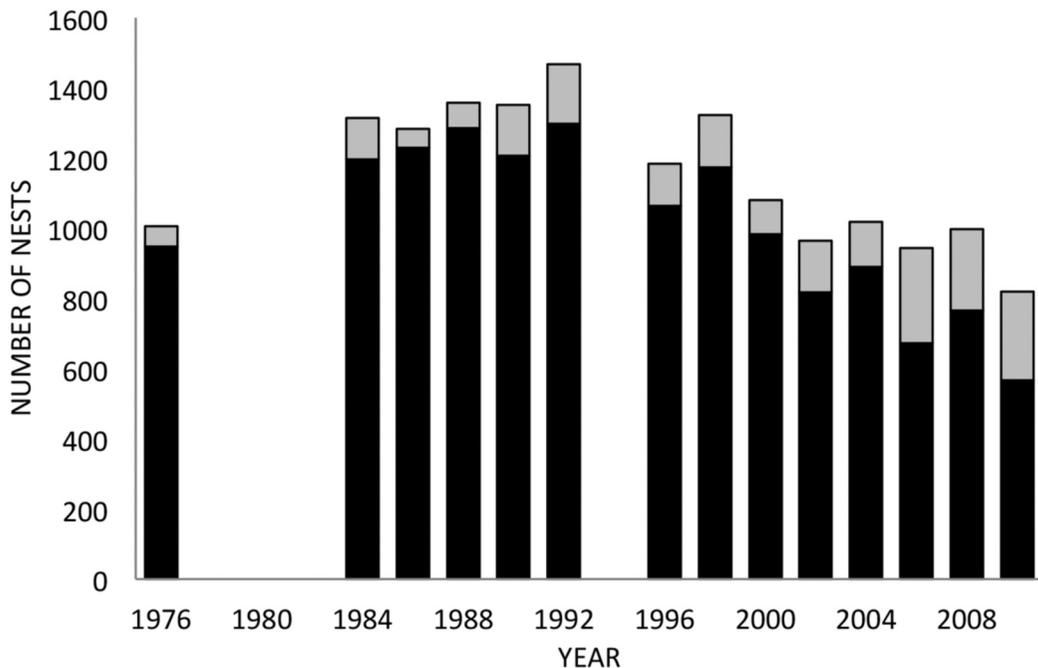


FIGURE 3. Comparison of occupied nests (solid bars) with empty nests (open bars) of Great Black-backed Gulls (*Larus marinus*) at Boot Island National Wildlife Area, 1976 to 2010.

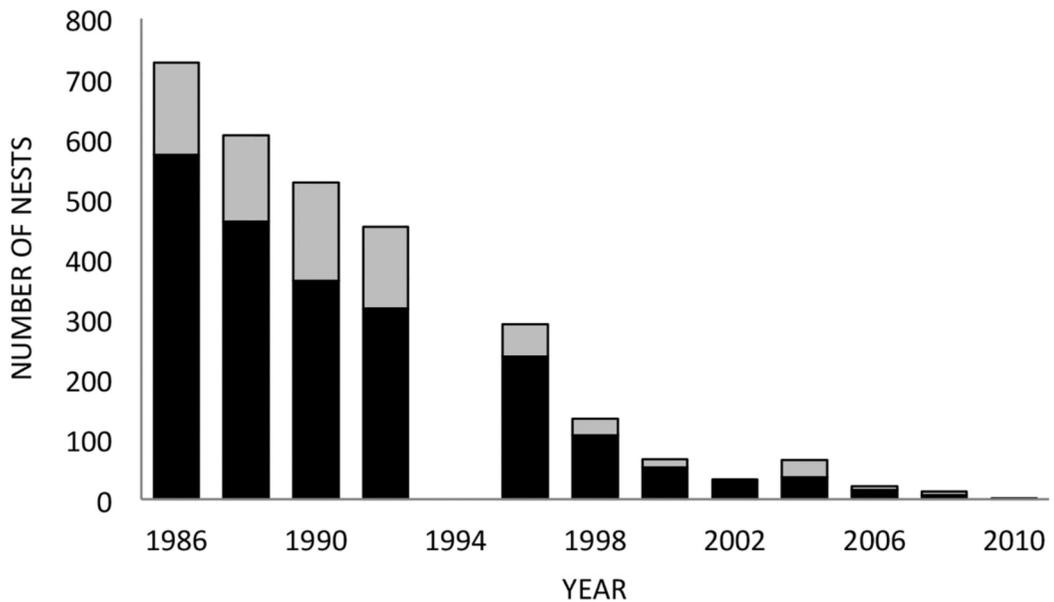


FIGURE 4. Comparison of occupied nests (solid bars) and empty nests (open bars) of Herring Gulls (*Larus argentatus*) at Boot Island National Wildlife Area, Nova Scotia, 1986 to 2010.

of the colony played a significant role in the observed reductions in gull numbers.

The cod fishery

In 1992 the North Atlantic Cod (*Gadus morhua*) population collapsed and the Canadian government placed a moratorium on the fishery. Chapdelaine and Rail (1997) were able to link this decline in the Atlantic cod fishery on the north shore of the Gulf of St. Lawrence with similar changes in nesting Herring Gull numbers on nearby islands. We do not know where the Boot Island Herring Gulls spend their time outside the breeding season, although some birds may winter along the eastern seaboard of the United States (see Drury and Nisbet 1973*; Gaston *et al.* 2008*). It may, however, not be coincidental that the rapid decline in Herring Gull numbers on the north shore of the Gulf of St. Lawrence from 1988 to 1993 (Chapdelaine and Rail 1997; Cotter and Rail 2007) roughly coincides with the Boot Island population crash from 1987 to 2002. Furthermore, changes observed at the Boot Island colony generally reflect regional trends for Great Black-backed and Herring Gulls in Nova Scotia from 1971 to 2002 (Cotter *et al.* 2012*).

Predation and disturbance

Coyote

The decline in both gull species coincide with the expansion of Coyote into Nova Scotia (Parker 1995). The range expansion and population increase of Coyotes in the province was rapid: provincial fur harvesters removed 777 animals in 1990–1991, with an increase to 1,887 animals in 1994–1995 (O'Brien and Boudreau

1998*). Coyotes are opportunistic predators (Berg and Chesness 1978; Parker 1995) and, in recent years, tracks and scat have been found on a number of off-shore islands. Coyote sign (scat) was first recorded on Boot Island in 1998 with additional evidence (tracks and scat containing small bones) in 2000 and 2002. In 2004, one animal was observed feeding on Great Black-backed Gull eggs (MacKinnon *et al.* 2007). This animal readily swam across the narrow channel dividing Boot Island from the mainland and, on arrival, promptly started consuming gull eggs. The presence of Coyotes on the island during nesting is now likely a yearly occurrence, as one animal was observed in the gull colony in 2010 and again on 12 May 2014 (MacKinnon *et al.* 2010*).

American Mink and Raccoon

We also recorded the presence of American Mink on the island in 2004, 2008 and 2010 and, more recently, Raccoon in 2010. Both are notorious consumers of eggs and the young of ground-nesting birds and Raccoons have a significant impact on gull colonies (Kadlec 1971; Ellis *et al.* 2007). American Mink have also been predators in off-shore Nova Scotia tern colonies, such as those on Country Island and The Brothers (D'Eon 2005*).

Bald Eagle

Bald Eagles are frequently observed over Boot Island and, in 2008, a breeding pair took up residence in a large White Spruce (*Picea glauca*) adjacent to the gull colony. Eagles are known predators of gulls (Buehler 2000) and, although we did not observe a preda-

tion attempt during our surveys or search for prey remains under the nest, there was a conspicuous absence of gull nests in the immediate vicinity of the eagle nest. As approximately 50% of the gull colony is within 300 m of the eagle nest, the close proximity of eagles may influence the reproductive success of breeding gulls through disturbance of normal activities during the breeding season (White *et al.* 2006).

Egg collection by humans

Hébert (1989) reported that, among other factors, human predation on gull eggs for food (egging) was partly responsible for the observed decline in Herring Gulls on Kent Island, New Brunswick. No comparable activity has been reported for Boot Island, and we attribute this absence to the hazardous waters surrounding the island and the lack of an “egging tradition” in the largely agriculture-based adjacent community. Thus, egging is not considered to be a factor in the Boot Island gull decline.

Conclusion

Populations of nesting Great Black-backed and Herring Gulls have been in decline on Boot Island, Nova Scotia, for about 25 yrs. The earlier decrease in Herring Gull numbers may be attributed to aggression by the larger and competing Great Black-backed Gulls; however, declines in both species suggest that other, likely multiple, factors were involved. The loss of the Atlantic cod fishery in 1992 has been linked to gull declines in a number of colonies (Chapdelaine and Rail 1997) and this regional reduction of food availability may also be a contributing factor in the loss of Herring Gulls on Boot Island.

Coyote access to near-shore islands, following their expansion into Nova Scotia in the early 1980s, has resulted in nest loss from predation on Boot Island. Additional predation of eggs and chicks by American Mink, Raccoons, and Bald Eagles may have further contributed to an increase in nest failure in recent years. These stressors have become cumulative to the point that the Herring Gull colony on Boot Island has been essentially extirpated. In 2010, the Herring Gulls and nests were almost completely absent, while the Great Black-backed Gull colony had declined to 56% of its peak in 1990. It is important to note that this study is based on short duration field observations conducted over a number of years and that any definitive cause and effect is beyond the scope of this paper. Further work, such as determining the foraging and wintering areas of the Boot Island gulls is required.

A combination of many factors appears to be responsible for the observed declines. A broad reduction in food resources caused by changes in fisheries and better landfill management; the arrival of the Coyote along with other nest predators, such as American Mink and Raccoon; and the recent establishment of an active Bald Eagle nest within the colony may all have contributed to the observed decline in gulls on Boot Island.

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