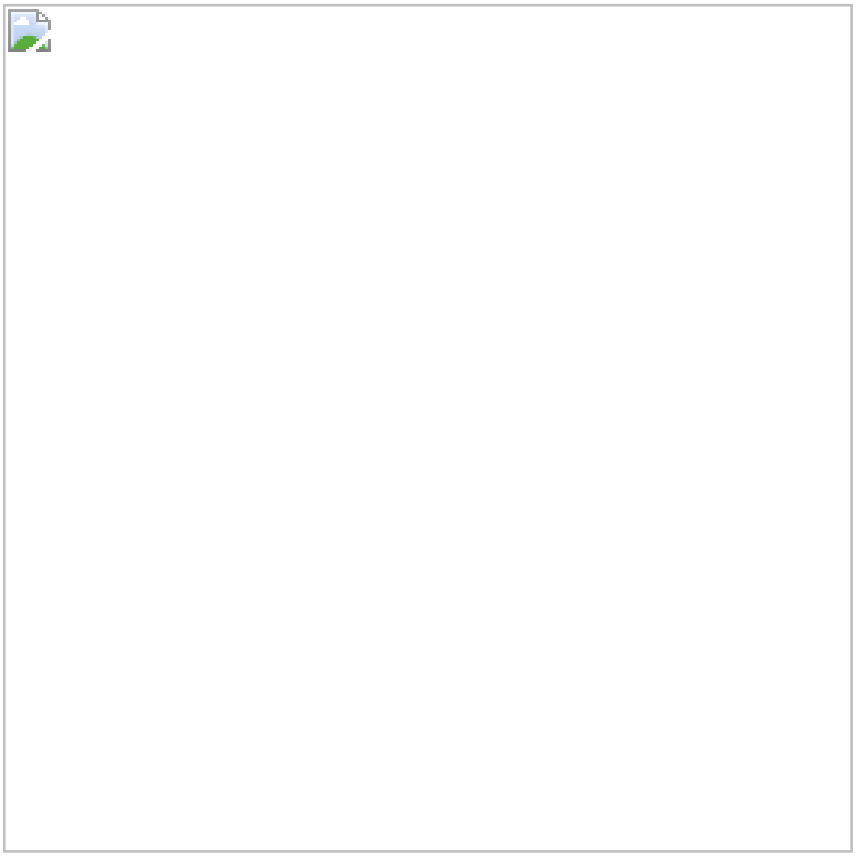

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Introduction: a Historical Perspective on Trends in Some Gulls in Eastern North America, with Reference to Other Regions

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Abstract.—This Special Publication of *Waterbirds* is the result of a symposium on the decline of some North Atlantic gull populations held in Wilhelmshaven, Germany, in October 2013 as part of the 37th Annual Meeting of the Waterbird Society. Here, we focus on the rise and subsequent decline in the 20th century of Herring Gull (*Larus argentatus*) and Great Black-backed Gull (*L. marinus*) populations in eastern North America with reference to other regions. In addition to survey reports, the Special Publication includes several papers on closely related species (Lesser Black-backed Gull, *L. fuscus*; Ring-billed Gull, *L. delawarensis*; and Kelp Gull, *L. dominicanus*) with contrasting population trends, and papers related to breeding biology, diet and predation, movement, demographics and contaminants. *Received 22 March 2015, accepted 20 December 2015.*

Key words.—baseline data, breeding, conservation, ecology, gull, life history, *Larus*, population change, recovery, survey.

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Gulls are ubiquitous elements of a broad range of habitats, from coastal beaches and the open sea to high mountain lakes. Members of the family Laridae (gulls) feed on a broad range of foodstuffs, from brine shrimp and fruit to fisheries discards and garbage. Nesting locations vary from offshore islands to trees to roof-tops. This degree of plasticity has led to near global distribution of gulls and significant population resilience in the face of both anthropogenic and non-anthropogenic environmental change. At the same time, the very success of larids as a group may have resulted in a degree of complacency in popular and conservation circles. The presence of gulls may be taken for granted, and shifts in distribution or abundance that would provoke immediate concern in other groups may be dismissed when seen in presumed common species.

This Special Publication of *Waterbirds* is the outcome of a symposium held in Wilhelmshaven, Germany, in October 2013 as part of the 37th Annual Meeting of The Waterbird Society. Participants in the symposium were struck by recent and seemingly dramatic drops in regional numbers of Herring Gulls (*Larus argentatus*) and Great Black-backed Gulls (*L. marinus*), as well as similar trends in Ring-billed Gulls (*L. delawarensis*), and compared notes on possible causes and consequences. We agreed that the question of population declines was of sufficient concern to warrant contacting additional researchers around the North Atlantic Basin to examine the extent of population shifts further and to propose appropriate management and conservation measures.

Herring and Great Black-backed gulls are of particular importance in assessing aquatic and marine environments because of their potential impact on other breeding species (Whittam and Leonard 1999; Donehower *et al.* 2007) and their consumption of a broad

range of foodstuffs and use of multiple habitats (Harris 1965; Andersson 1970; Calvino-Cancela 2011). In addition, gull foraging and other behaviors have been associated with disease transmission (Coulson *et al.* 1983; Monaghan *et al.* 1985). While their status as generalists may buffer them against shifts in particular food sources, changes in foraging behaviors, food brought back to nests, and regional populations make gulls potential indicators of large-scale changes in aquatic conditions (Hebert *et al.* 2008; Gebbink *et al.* 2011) similar to that suggested in other seabirds (Furness and Tasker 2000; Diamond and Devlin 2003). Historical increases and declines in gull populations have coincided with changes in human land-use practices (Cotter *et al.* 2012) and may in the future serve as sentinels for the effects of climate change (Blight *et al.* 2015).

Herring and Great Black-backed Gull Trends in Eastern North America

The rise of Herring and Great Black-backed gull populations in the eastern United States during most of the 20th century was documented by Drury (1973, 1974). Nisbet *et al.* (2013) and papers in this Special Publication evaluate more recent trends in both species. Data for the coastal northeastern United States and the Bay of Fundy, Canada, were relatively plentiful, if inconsistently collected, for the 20th century with a series of surveys for seabird protection between 1900 and the 1930s and subsequent gull control operations until the early 1950s (summaries in Knight 1908; Palmer 1949; Drury 1974; Nisbet *et al.* 2013). Beginning in the 1970s, the U.S. Fish and Wildlife Service conducted periodic surveys of seabirds, including gulls, along the eastern seaboard of the United States (Erwin and Korschgen 1979; Schauffler 1998; Nisbet *et al.* 2013; Mittelhauser *et al.* 2016), while the Canadian Wildlife Service conducted separate but comparable surveys in the same time frame in Atlantic Canada (Cotter *et al.* 2012; Wilhelm *et al.* 2016).

Information for the eastern United States prior to 1900 is anecdotal at best and subject to different interpretations. The archaeological evidence (Spiess and Lewis 2001; A. E. Spiess, pers. commun.) shows no signs of gulls as a component of Native American diet prior to the 19th century. Cogswell (1815) stated "It is however a remarkable fact, that birds of no kind abound in Maine." Audubon (1835) stated that the Herring Gull breeds ". . . from off Boston to Eastport. . ." (in Maine, USA), but there is no evidence that he visited any colonies west of the Bay of Fundy, Canada. It is striking that his work on Herring Gulls was restricted to the Grand Manan archipelago, in the Bay of Fundy, where he describes them as common, and his work on Great Black-backed Gulls was restricted to Labrador, Canada. Norton (1924) was clearly skeptical of some of Audubon's claims and believed that while nesting occurred "we have found no evidence that its [Herring Gull's] range was continuous even then, but rather interrupted." Norton and Allen (1931) completely dismissed Audubon's suggestion that Great Black-Backed Gulls nested in Maine. Given the presence of the sea mink (*Mustela macrodon*), a large, highly aquatic mustelid commonly found on Maine islands prior to the mid-19th century (Hardy 1903), ground nesting of Herring or Great Black-Backed gulls on at least nearshore islands would seem unlikely. The sea mink did not, however, reach the Bay of Fundy (Black *et al.* 1998), and this may explain both the abundance of gulls reported on the Canadian islands and their relative absence in Maine. Hardy (1903) stated that the sea mink was subject to heavy trapping pressure throughout the 19th century and became rare as early as the 1860s – precisely when seabird populations were known to be expanding. The last sea mink was trapped in 1895. During the same period, Bald Eagles (*Haliaeetus leucocephalus*), which had been common in Colonial times (Josselyn 1865), were largely eliminated from Maine (Knight 1908).

Regardless of any estimates of prior range, it seems safe to suggest that at the beginning of the third quarter of the 19th century, the Atlantic center of Herring and Great Black-backed gull breeding populations in North America lay north and prob-

ably east of the continental United States. In Newfoundland and Labrador, Canada, little is known, as regular surveys have only been carried out recently (Cotter *et al.* 2012); however, both Herring and Great Black-backed gulls appear to have been abundant as breeders and common in winter, especially in southern Labrador and along the Newfoundland coast (Audubon 1835; Coues 1862; Hantzsch 1928; Austin 1932). Great Black-backed Gulls were also a common breeder during the 19th century in the Maritime Provinces of Canada, but experienced a large decline in the early 20th century such that they could only be found during winter months throughout the 1940s (Christie *et al.* 2004). By the 1960s, populations appeared to have rebounded and Great Black-backed Gulls were year-round residents again (Boyer 1972), with southern Nova Scotia hosting one of the largest colonies of this species in North America (Tufts 1973). Meanwhile, Herring Gulls were not abundant in the Maritime Provinces of Canada at the beginning of the 1900s (Christie *et al.* 2004), but numbers grew rapidly over the next 50 years (Squires 1976) with Kent Island and adjacent islets in the Bay of Fundy supporting the most important colony in North America during the 1930s and 1940s (Ronconi and Wong 2003; Christie *et al.* 2004). The species' range expanded to remote offshore islands in Nova Scotia by the 1950s (Erskine 1954; Ronconi *et al.* 2016).

As Herring Gull numbers increased in the Maritime Provinces of Canada, their breeding range expanded to the west and south, only to be almost eliminated again as breeders in the eastern United States by a combination of egging and plume hunting toward the end of the 19th century (Drury 1973). Drury (1973) also stated that the passage of a series of protective legislative acts coupled with changes in fashion, abandonment of human settlements on many outer islands, and the provision of an enhanced food supply in the form of open landfills and fisheries discards led to another rapid southward expansion of Herring and Great Black-backed gulls. It should be noted however that Coulson (2015) rejects the importance of open landfills as an explanation for Herring Gull increases in the United Kingdom and other areas, and emphasizes the importance of a decrease in persecution. Great Black-backed Gulls nested on the Isles of Shoals along the Maine-New Hampshire border by 1928 (Norton and Allen 1931; Jackson and Allan 1932), Massachusetts by 1931 (Eaton 1931), New York by 1942 (Wilcox 1944) and North Carolina by 1972 (Pernell and Soots 1975). Herring Gulls increased in number and also expanded their breeding range to the south, breeding in Massachusetts by 1912 and New York by 1933 (Allen 1933). Further expansion was summarized by Hailman (1963), who listed the species as reaching North Carolina by 1961. Colonies in South Carolina, active in the 1960s, were abandoned by the early 2000s (Jodice *et al.* 2007).

In 1934, the U.S. Fish and Wildlife Service initiated an extensive gull control program in coastal New England (later expanded to cormorants) (Palmer 1949). Reasons for this program included concern about the impact of Herring Gulls on blueberry (*Vaccinium angustifolium*) and cranberry (*V. macrocarpon*) crops, loss of fish fertilizer in farm fields, and the impact of Herring Gulls on fishing weirs in Maine (Drury 1963). From 1934 to 1950, a total of 831,431 presumed Herring Gull eggs (an unknown number of Great Black-backed Gull eggs were included in totals) were needled, smashed or oiled between Massachusetts and the Canadian border (Gross 1950). The ultimate effect of this effort on the regional population is hard to determine. Some colonies showed significant declines, while others were probably replenished with birds moving south from Canada. Drury (1963) stated that at the height of the program population growth for Massachusetts "had almost stopped" but that the reasons for the continued increase in Maine "remained obscure." Gross (1950) expressed disappointment in the results for Maine, and advocated continuing the program indefinitely; however, it was ended in 1953 (Drury 1973).

Audubon (1835) and subsequent authors (Gross 1945) commented on Great Black-backed Gulls' ability to prey on other gulls

and waterfowl. Concern over the impact of gull predation on tern (*Sterna* spp.) nesting colonies (Drury 1965; Hatch 1970; Whittam and Leonard 1999) led to selective management of gulls in New England and parts of Atlantic Canada (Kress 1983; Anderson and Devlin 1996; Kress and Hall 2004; Donehower *et al.* 2007). Predation by gulls on terns has also been reported from Europe (Becker 1995). Population increases of gulls and their impacts on other species were reviewed by Blokpoel and Spaans (1991), though the situation may be more complex than once thought (Finney *et al.* 2003; Oro and Martínez-Abraín 2006; Ronconi *et al.* 2016). Coulson (1991) also discussed the impact of gulls on other species as a reason for lethal management in the United Kingdom, although he listed other justifications including protection of water supplies and reduction of noise and general nuisance in towns. Management efforts were generally highly focused and probably only impacted gull populations in the immediate vicinity of other seabird colonies, but the value of these efforts may need to be re-evaluated.

Nisbet (2001) and Nisbet *et al.* (2013) have pointed out the difficulties in deriving population trends from survey numbers arrived at using different methods. Nisbet *et al.* (2013) gave a detailed summary of general patterns for the eastern United States and the Bay of Fundy, Canada, while repeatedly cautioning readers about the variability observed both among and within populations counted using different methodologies. Their conclusion was that overall Herring Gull numbers may have peaked at some point during the 1970s, while Great Black-backed Gulls peaked in the 1990s. This difference in timing of peak numbers of the two species is one of the many mysteries that have yet to be explained fully. Populations of both species then began to decline at differing rates and beginning at differing times from region to region. This trend has continued and may be accelerating in Maine (Mittelhauser *et al.* 2016). Washburn *et al.* (2016) found similar patterns for New York, but they found that Herring Gull populations in New Jersey showed no trend whereas Great Black-backed Gulls were still increasing. Meanwhile, to the north in Witless Bay, Newfoundland, Canada, studies beginning in the late 1960s showed an increase in Herring and Great Black-backed gulls through the 1970s, followed by a steady decline to the present (Robertson *et al.* 2001; Cotter *et al.* 2012; Bond *et al.* 2016). Herring and Great Black-backed gulls in Newfoundland have switched primary prey sources and decreased in number in some areas, presumably in response to large changes in the marine environment, including the 1992 groundfish fishery closure (Massaro *et al.* 2000; Regular *et al.* 2013). Though gulls are less abundant and less frequently surveyed in Labrador, Canada, limited information suggests a recent decline there as well (Robertson *et al.* 2002; Robertson and Chaulk 2016).

Case Study Comparisons: Other Regions and Other Gull Species

To determine what drives Herring and Great Black-backed gull trends in eastern North America, it may be helpful to consider what is happening to these species in other parts of their range. Information on both Herring and Great Black-backed gulls in the United Kingdom is summarized by Holloway (1996). Prior to the 20th century, Herring Gull populations in Britain were regarded as "always abundant" (Parslow 1973) though Fleming (1828) listed both Herring and Great Black-backed gulls as "resident." Both were reported nesting on the Bass Rock on the east coast of Scotland by Dresser (1881), who also stated that Herring Gulls nested near Plymouth.

In the first part of the 20th century, gull populations increased in the United Kingdom (Chabrzyk and Coulson 1976; Coulson 1991) and Finland (Hario and Rintala 2016). Large-scale surveys across Britain and Ireland took place in 1969-1970, 1985-1988, and 1998-2002, and showed overall declines in Herring and Great Black-backed gulls, as well as shifts to more urban settings (Mitchell *et al.* 2004; Nager and O'Hanlon 2016), which have been attributed to changes in landfill practices and the availability of fish-

eries discards (Hudson and Furness 1989; Furness *et al.* 1992). Big increases that occurred during much of the 20th century have now reversed. In the case of the Herring Gull, this decline was pronounced, while the declines of both the Great and Lesser Black-backed gulls (*L. fuscus*) were less extreme and began somewhat later. Shifts in nesting habitat have partially coincided with changes in population trends. Coulson (2015) presented arguments for disease avoidance being a driving factor for gull movement to cities and towns, and cited lethal management as a contributing factor to their overall decline. In Finland, the same pattern of an increase throughout the first part of the 20th century followed by a decline in recent decades is also seen in Herring, Lesser Black-backed, and Great Black-backed gulls (Hario and Rintala 2016). They point out that reproductive success has only been studied in depth in the country's Lesser Black-backed Gull population, and suggest that anthropogenic influences may be playing a role in species' declines. Records for Greenland are scant; Boertmann and Frederiksen (2016) suggest both Great and Lesser Black-backed gulls may be expanding their range, while the smaller population of Herring Gulls remains stable.

A second path to understanding the current North American declines is to compare the life histories and ecology of Herring and Great Black-backed gulls with other species of Laridae. This Special Publication includes status reports for the Kelp Gull (*L. dominicanus*), which is thriving in both South Africa (Whittington *et al.* 2016) and South America (Yorio *et al.* 2016), and for the Ring-billed Gull (*L. delawarensis*), which shares a range with Herring and Great Black-backed gulls and is facing a similar decline at least in northeastern North America (Giroux *et al.* 2016).

In addition to documenting trends by region, we have included papers aimed at examining some of the putative causes of Herring and Great Black-backed gull declines, including hypotheses about habitat suitability (Perlut *et al.* 2016), prey availability (Bond 2016; Bond *et al.* 2016; Wilhelm *et al.* 2016), climate change (Robertson 2016) and the effects of elevated levels of organic contaminants (de Solla *et al.* 2016; Pekarik *et al.* 2016). Several papers touch on a more general ecology, commenting on the nonbreeding distribution of gulls in Canada (Gjerdrum and Boldoc 2016) and the United States (Clark *et al.* 2016), and weigh the role of gulls as predators in a changing system (Veitch *et al.* 2016). The last section of this Special Publication concerns reports of life history and is applied to offer recommendations to field ornithologists; in particular, the effect of brood size on nestling growth (Gilliland *et al.* 2016), spatial variation in gull morphology (Robertson *et al.* 2016b), discriminating between eggs of Herring and Great Black-backed gulls (Diamond and Otorowski 2016) and survivorship measurements in the Great Black-backed Gull (Robertson *et al.* 2016a) are reported.

Research Gaps

Despite the significant progress described in this Special Publication, there remain significant gaps in our knowledge of Herring and Great Black-backed gulls. Standardization of survey methodology, timing, and regional coverage is inconsistent at best and renders precise estimates of population trends difficult if not impossible. There is a need for coordinated reporting and archiving of both local and regional estimates, with descriptions of methodology and estimated error. There is at present no satisfactory explanation of the apparent lag between changes in Herring Gull numbers in the eastern United States and corresponding shifts in Great Black-backed Gulls. Mitchell *et al.* (2004) discussed the role of botulism in reducing a number of gull colonies in the United Kingdom; however, it is not known how prevalent botulism might be in other portions of the species' ranges. The present systems in the United States and Canada of counting colonies (primarily from the air) every 5 to 10 years does not lend itself to assessing the impact of disease as a cause of colony decline (Shauffler 1998; Allen *et al.* 2012; Cotter *et al.* 2012). Periodic

assessment of the presence of pathogens within a regional population and greater coordination among researchers might provide better information regarding effects on overall trends.

The status of inland populations in North America, and more recent updates from mainland Europe, also need further research. Inland waterbirds often experience different threats than their coastal counterparts, such as eutrophication and altered food webs from introduced species (Wilson *et al.* 2014). More broadly, the regional variability in the timing, direction and extent of changes in recorded numbers of nesting birds suggest that no one cause can be assigned to all regions. Given the strong evidence for broad-scale climate change across the entire Northern Hemisphere, shifts in both regional population sizes and distributions are to be expected. Better understanding of climatic effects on prey sources and habitat would seem essential to predictive models of species abundance. The role of individual specialization is also important for understanding gull predation on sympatric species, as well as the role of diet in regulating gull populations and explaining movement and survival patterns.

Human attitudes toward gulls have undergone a series of transformations over the course of the last century and a half. For much of this period, they have been treated as pests, sources of food or decoration, or threats to other species, and as such they were subjected to widespread management and persecution. When populations dipped below an often arbitrary threshold, gulls were rehabilitated as essential members of the aquatic community (Thayer *et al.* 1900) and protected, only to once again be subjected to disturbance and lethal management when their numbers rose to another often arbitrary threshold (Gross 1950). Evidence presented here and elsewhere suggests that gulls in the greater North Atlantic region may be facing population declines in response to a broad range of factors. Whether the status of these species leads to yet another shift in our attitude and responses to this group remains to be seen.

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