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Historical and Current Population Trends of Herring Gulls (*Larus argentatus*) and Great Black-backed Gulls (*Larus marinus*) in the New York Bight, USA

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Abstract.—During the 20th century, gull populations in North America experienced considerable changes in abundance and geographic ranges. The objective of this study was to describe population trends of Herring Gulls (*Larus argentatus*) and Great Black-backed Gulls (*L. marinus*) in the New York Bight, USA, over a 40-year period (1974-2013). A variety of data sources using different survey methods provided estimates of the number of breeding pairs for both species. In the Long Island portion of the New York Bight, overall Herring and Great Black-backed gull nesting populations appear to have fluctuated considerably in size during this time period, and the largest numbers of breeding individuals of these two species occurred in the 1980s. In coastal New Jersey, the Herring Gull nesting population has remained relatively constant, whereas the Great Black-backed Gull nesting population has increased. Individual nesting colonies are dynamic and can vary in size considerably during even short time periods. Several factors, including sea-level changes and the availability of anthropogenic food sources (i.e., at landfills and fisheries by-catch), likely have strongly influenced individual colonies and the overall Herring and Great Black-backed gull breeding populations in the New York Bight. Received 7 July 2014, accepted 22 June 2015.

Key words.—Great Black-backed Gull, Herring Gull, *Larus argentatus*, *Larus marinus*, nesting colonies, New York Bight.

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Around the world, the ranges and abundance of different species of gulls increased substantially during the latter half of the 20th century (Blokpoel and Spaans 1991; Aumen *et al.* 2008; Coulson and Coulson 2009). Populations of several gull species have increased considerably in North America, potentially due to the availability of human-derived food sources such as waste management facilities (e.g., landfills), discards from fishing enterprises, agricultural production areas, and other anthropogenic food sources (e.g., obtained while scavenging in urban areas) (Good 1998; Duhem *et al.* 2005; Washburn *et al.* 2013).

During the past century, Herring Gulls (*Larus argentatus*) have expanded their breeding range south along the Atlantic Coast of the USA, first colonizing Maine and Massachusetts. The first documented nesting of Herring Gulls in New York occurred in 1931 at Orient, New York, and by 1941 there were six documented nesting colonies (Cruickshank 1942). During the 1950s and

1960s, Herring Gull nesting spread widely across Long Island, New York, with large nesting colonies present on Cartright Island, on Gardiner's Island, in Captree State Park, and on Canarsie Pol in Jamaica Bay, New York (Bull 1964). Further increases and range expansion of Herring Gulls occurred during the 1950s and 1960s; the estimated number of Herring Gull breeding pairs on Long Island increased from 225 in 1951 to 5,550 in 1972 (Drury and Kadlec 1974). Although the New England Herring Gull population was apparently stabilizing during this time period (Kadlec and Drury 1968; Drury and Kadlec 1974), this species continued its range expansion southward into North Carolina (Stewart and Robbins 1958; Ames 1963; Burger 1977; Brinker *et al.* 2007).

Great Black-backed Gulls (*L. marinus*) also expanded their range southward from New England during the past century. The first documented nesting of Great Black-backed Gulls in New York occurred in 1942 (Cruickshank 1942). During 1955-1962,

seven Great Black-backed Gull nesting colonies occurred on Long Island, including one on Canarsie Pol Island in Jamaica Bay, New York, the southernmost known nesting colony at that time (Bull 1964). Great Black-backed Gulls expanded their range southward to Maryland and Virginia during the 1970s (Brinker *et al.* 2007).

During the last 40 years, little information has been published regarding the size and distribution of Herring and Great Black-backed gull nesting colonies within the New York Bight. Such information is essential to State and Federal wildlife management agencies protecting this natural resource within the New York Bight, while at the same time wildlife management agencies are involved in the reduction of human-gull conflicts (Belant 1997; Rock 2005). Herring and Great Black-backed gulls have the potential to negatively impact other birds such as plovers and terns (Olijnyk and Brown 1999; Booth and Morrison 2010) and Laughing Gulls (*Leucophaeus atricilla*; Burger and Shisler 1978); therefore, a better understanding of gull ecology within the New England and Mid-Atlantic Regions of the USA is needed (Washburn *et al.* 2013). The objective of our study was to describe population trends of breeding Herring and Great Black-backed gulls in the New York Bight region from the late 1970s to 2013.

METHODS

Study Area

The study area consists of the New York Bight region (Fig. 1), primarily in the Coastal Plain flatlands and marine shorelines of Long Island (New York), the New York-New Jersey Harbor, and eastern New Jersey (U.S. Fish and Wildlife Service 1997; Kennish 1998). Herring and Great Black-backed gull nesting colonies are located throughout this area within tidal estuarine wetlands, salt marshes, islands, barrier beaches, as well as in old fields, on building rooftops, and in other habitats (Pierotti and Good 1994; Good 1998).

Gull Breeding Population Assessments

State and Federal wildlife management agencies have conducted a series of systematic colonial waterbird surveys in the New York Bight from the 1970s through today. The timing of these surveys is consistent with peak incubation and initial hatching of eggs for Her-

ring and Great Black-backed gulls (Pierotti and Good 1994; Good 1998). These surveys include information about the abundance and location of Herring and Great Black-backed gull nesting colonies and, thus, collectively provide an excellent resource for evaluating breeding population trends for these two species.

New York. Data regarding Herring and Great Black-backed gull populations in New York (Long Island) was obtained from several sources. Nesting population estimate data for these two species during 1974-1978 were found in Buckley and Buckley (1980). Data from 1977 and 1985 were found in the precedent setting work of Erwin and Korschgen (1979) and Andrews (1990), respectively. Most of the information on Herring and Great Black-backed gull populations in New York was obtained from the Long Island Colonial Waterbird and Piping Plover Survey (Survey). This Survey is a systematic monitoring effort that is conducted to estimate the abundance of breeding gulls (and many other species of colonial waterbirds) within the coastal areas of New York, including Nassau and Suffolk Counties and the boroughs of New York City (Litwin *et al.* 1993; Sommers *et al.* 1994, 1996, 2001). The Survey was conducted in 16 individual years (i.e., 1985-1993, 1995, 1998, 2001, 2004, 2007, 2010, and 2013). The New York City Audubon Harbor Herons Nesting Surveys, an annual survey (1985-2013) consisting of ground counts for colonial waterbirds nesting in the New York Harbor, was also a source of information (Craig 2013). Lastly, specific information regarding Herring and Great Black-backed gull nesting in Gateway National Recreation Area, located on eastern Long Island, was obtained from Washburn (2010, 2013). During each visual ground survey (adult count), the total number of adult Herring and Great Black-backed gulls present on an individual island or marsh was recorded, and the general locations of any nesting activity or colonies mapped. Consistent with standard protocols, it was assumed that one nest was present for each adult observed during the survey and that the other member of the breeding pair was foraging away from the colony (Erwin and Korschgen 1979; Sommers *et al.* 2001). Visual ground surveys were often conducted using binoculars and spotting scopes to minimize disturbance to actively nesting gulls and other birds.

New Jersey. Data regarding Herring and Great Black-backed gull populations in New Jersey were obtained from several sources as well. Data from 1977 and 1985 were found in Erwin and Korschgen (1979) and Andrews (1990), respectively. Most of the information on Herring and Great Black-backed gull populations in New Jersey was obtained from Jenkins *et al.* (1989) and also from surveys conducted by the New Jersey Department of Environmental Protection. Colonial waterbird surveys in coastal New Jersey were conducted during 11 individual years (i.e., 1977, 1978, 1979, 1983, 1985, 1989, 1995, 2001, 2004, 2007, and 2013). Aerial surveys (Frederick *et al.* 1996; Green *et al.* 2008) to estimate gull breeding populations were conducted from a Bell Jet Ranger helicopter carrying three personnel (two surveyors and a mapper). The mapper directed the pilot,

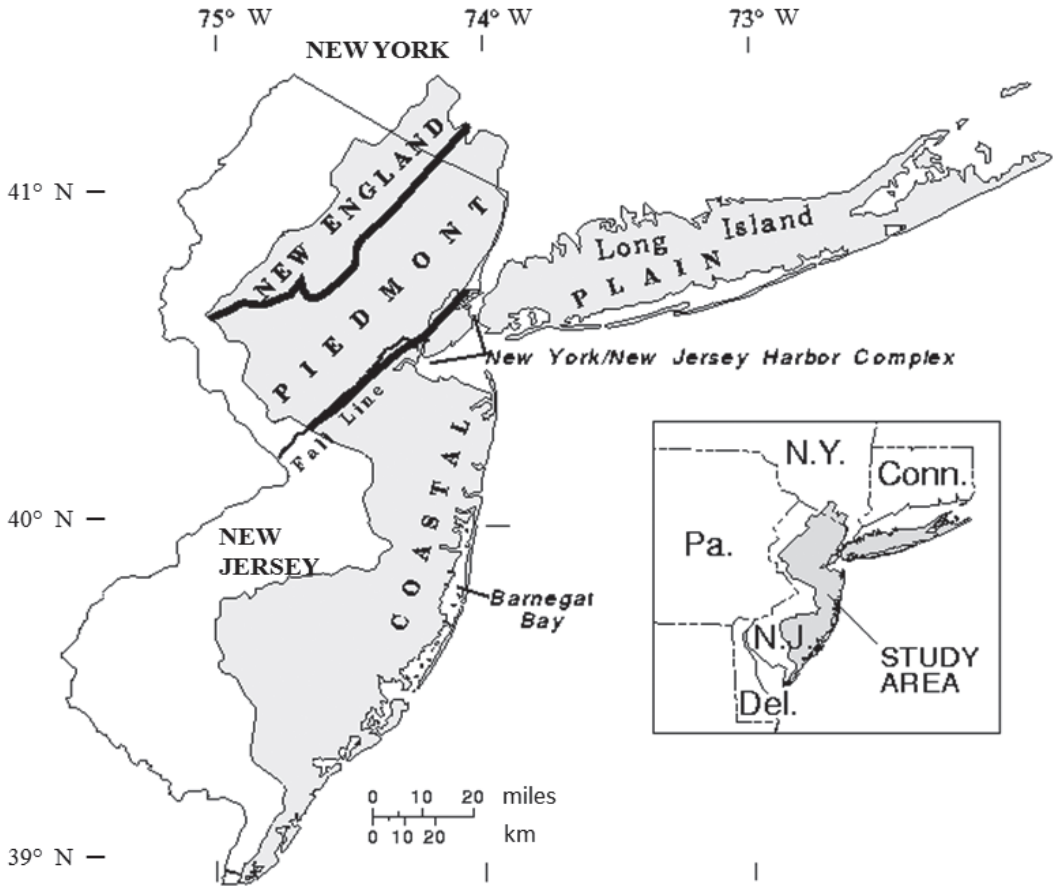


Figure 1. Map of the study area that depicts the location of the New York Bight. The inset box shows the location of the study area relative to the States of New York (N.Y.), New Jersey (N.J.), Connecticut (Conn.), Pennsylvania (Pa.), and Delaware (Del.).

marked the boundaries of colonial waterbird colonies on topographic maps, and kept tallies of each species, which were provided by the surveyors. The surveyors worked together to count the number of Herring and Great Black-backed gulls, as well as other species, in each colony (Jenkins *et al.* 1989). Consistent with standard protocols, it was assumed that one nest was present for each adult Herring or Great Black-backed gull observed during the survey and that the other member of the breeding pair was foraging away from the colony (Erwin and Korschgen 1979; Jenkins *et al.* 1989).

Data Analyses

We used linear regression analyses and analysis of variance to examine potential trends in the total number of nesting pairs of Herring and Great Black-backed gulls, by species, within New York during 1974-2013 and within New Jersey during 1977-2013 (Zar 1996). We considered differences to be significant at $P \leq 0.05$ and conducted all analyses using SAS statistical software (SAS Institute, Inc. 2008). Data are presented as mean \pm SE.

We determined the total number of Herring and Great Black-backed gull nesting colonies on Long Island and in New Jersey when this information was available within the survey data; this was the case for the majority of the nesting surveys conducted. The presence of at least three gulls (thus representing three nesting pairs or nests) was required for a location to be considered an active gull nesting colony (Buckley and Buckley 1980). We used analysis of variance to determine if differences existed in the average number of active gull nesting colonies, by species and by State, during each decade (i.e., 1970s, 1980s, 1990s, and 2000s) and considered differences to be significant at $P \leq 0.05$ (Zar 1996).

We examined individual Herring and Great Black-backed gull nesting colonies from Long Island and New Jersey, respectively, to determine if size of individual nesting colonies varied over time. For each individual nesting colony, we examined the estimated number of nesting Herring and Great Black-backed gulls every third year from 1986 to 2013 on Long Island and during five different years from 1995 to 2013 in New Jersey.

RESULTS

New York. During 1974-2013, an average of 14,281 ($\pm 1,467$ SE) nesting pairs of Herring Gulls was estimated on the Long Island portion of the New York Bight (Fig. 2). Over this 40-year period, the Herring Gull nesting population on Long Island fluctuated considerably. Decadal means of Herring Gull nesting pairs varied ($F_{3,20} = 18.99$, $P < 0.001$), with the highest numbers occurring during the 1980s and the lowest during the 2000s (Table 1).

The total number of active Herring Gull nesting colonies on Long Island fluctuated during these 40 years. Decadal means of the total number of active Herring Gull colonies varied ($F_{3,20} = 5.32$, $P = 0.009$), with the number of active colonies occurring during the 2000s being lower than during previous decades (i.e., 1970s, 1980s, and 1990s; Table 2).

The size of individual Herring Gull nesting colonies on Long Island showed considerable variation across years (Fig. 3). Some of the larger colonies (e.g., Captree State Park, North and South Brothers Islands) showed sharp declines and eventually ceased to be active, while new colonies (e.g., Young's Island, Riker's Island) appeared during the same time period. Interestingly, other colonies (e.g., Isle of Meadows, Prall's Island) showed a very ephemeral pattern; they formed, peaked, and became inactive during a 20-year period.

An average of 4,772 ($\pm 1,243$ SE) nesting pairs of Great Black-backed Gulls was estimated on the Long Island portion of the New York Bight during 1974-2013 (Fig. 2). Similar to Herring Gulls, the overall size of the Long Island Great Black-backed Gull nesting population fluctuated during these 40 years. Decadal means of Great Black-backed Gull nesting pairs varied ($F_{3,20} = 42.22$, $P < 0.001$), with the highest numbers occurring during the 1980s and the lowest during the 1970s (Table 1).

The total number of active Great Black-backed Gull nesting colonies on Long Island remained constant during this 40-year period. We found no differences ($F_{3,20} = 0.50$,

$P = 0.69$) in the decadal means of the total number of active Great Black-backed Gull colonies during the 1970s through the 2000s (Table 2).

Similar to Herring Gulls, Great Black-backed Gull nesting colonies on Long Island showed considerable variation across years (Fig. 3). The largest nesting colony on Long Island was located on Gardiner's Island during the entire 40 years surveys were conducted; however, this particular colony declined by 74% from 1986 to 2013. A few new Great Black-backed Gull nesting colonies (e.g., Young's Island) formed. Many of the nesting colonies (e.g., West Inlet Island, Swinburne Island) fluctuated considerably with regard to the number of estimated nesting pairs of Great Black-backed Gulls but remained active during the 40-year period.

New Jersey. During 1977-2013, an average of 6,086 (± 544 SE) nesting pairs of Herring Gulls was estimated in the New Jersey portion of the New York Bight (Fig. 4). Over this 37-year period, the Herring Gull nesting population in New Jersey remained constant ($y = -27,762 + 16.993x$; $R^2 = 0.01$, $F_{1,10} = 0.13$, $P = 0.73$).

During 1977-2013, an average of 52.1 (± 4.03 SE) active Herring Gull nesting colonies occurred in New Jersey. The total number of active Herring Gull breeding colonies in New Jersey remained relatively constant during this time period (Table 3).

The size of individual Herring Gull nesting colonies in New Jersey showed variation across years (Fig. 5). Some colonies (e.g., Anglesea Marsh, Roundabout Thorofare) showed sharp declines and eventually ceased to be active, while a few new colonies (e.g., Gull Island, Stake Thorofare) appeared; however, most of the colonies (e.g., Middle Island, Rainbow Island) fluctuated considerably with regard to the number of estimated nesting pairs of Herring Gulls but remained active.

An average of 625 (± 186 SE) nesting pairs of Great Black-backed Gulls was estimated in the New Jersey portion of the New York Bight during 1977-2013 (Fig. 4). Over this 37-year period, the number of nesting pairs of Great Black-backed Gulls in New

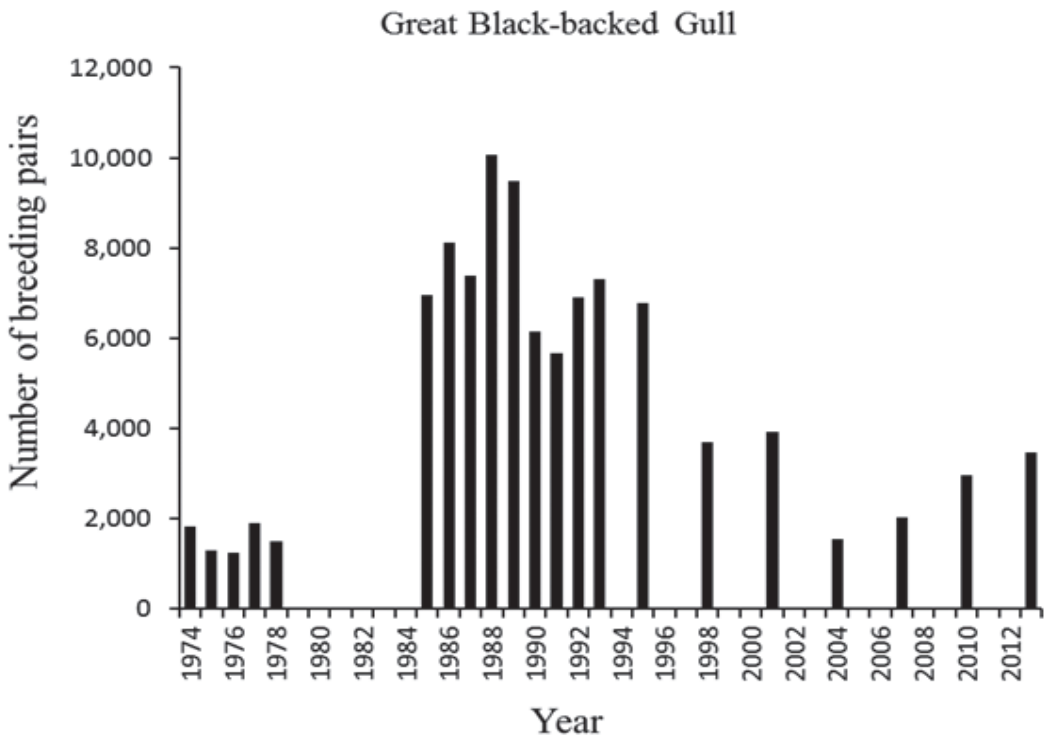
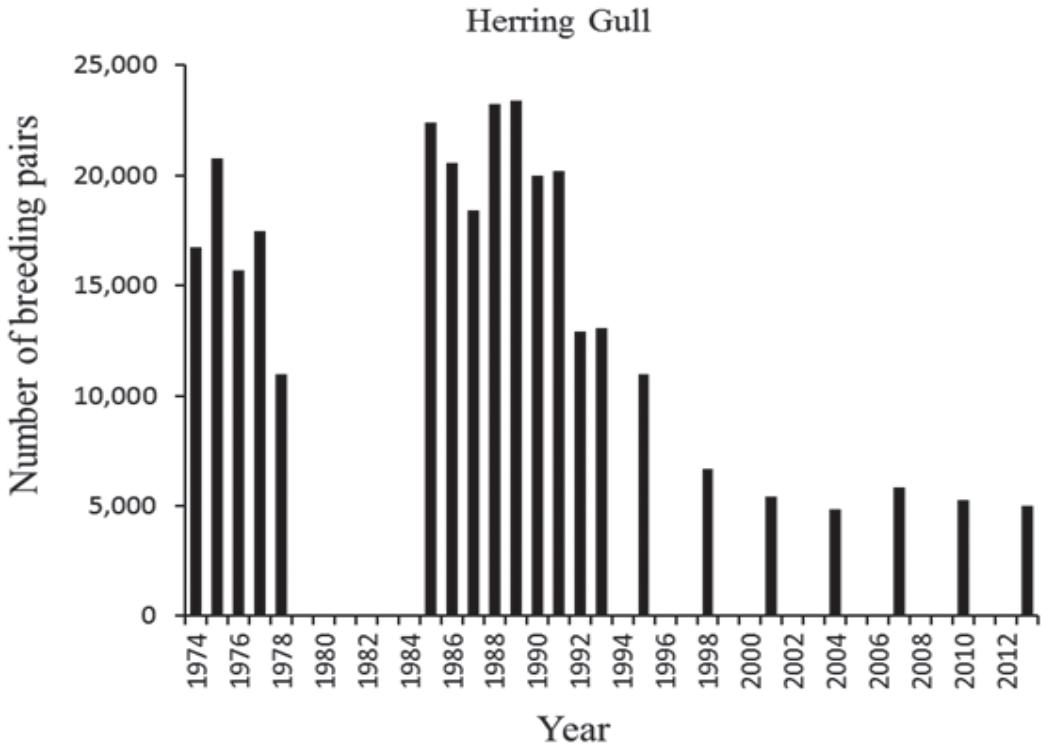


Figure 2. Population trends of Herring Gulls and Great Black-backed Gulls in New York (i.e., Long Island) during 1974-2013. All populations are complete censuses of all known colonies expressed as number of breeding pairs.

Table 1. Mean (\pm SE) number of nesting pairs of Herring Gulls and Great Black-backed Gulls, by decade, on Long Island, New York during 1974-2013.

Decade	Herring Gulls		Great Black-backed Gulls	
	Mean	SE	Mean	SE
1970s	16,331 A ¹	1,582	1,557 A	134
1980s	21,612 B	943	8,400 B	596
1990s	8,431 A	2,154	4,717 C	531
2000s	5,275 C	172	2,787 A	440

¹Decadal means within the same column with the same letter are not significantly different ($P > 0.05$).

Jersey increased ($y = -87,350 + 44.166x$; $R^2 = 0.83$, $F_{1,10} = 45.25$, $P = 0.001$) by 2,050%.

During 1977-2013, an average of 39.4 (± 3.73 SE) active Great Black-backed Gull nesting colonies occurred in New Jersey (Table 3). Although the number of active Great Black-backed Gull nesting colonies increased considerably during the 1980s and early 1990s (e.g., in 1995 there were twice as many active colonies compared to 1977), the number of active Great Black-backed Gull nesting colonies in New Jersey remained relatively constant during the late 1990s and 2000s (Table 3).

Most of the Great Black-backed Gull colonies in New Jersey were much smaller (in size) relative to the Gardiner's Island nesting colony on Long Island, but proportionally they varied in size over time in similar patterns. Similar to Herring Gulls, some Great Black-backed Gull nesting colonies (e.g., Anglesea Marsh) declined and eventually ceased to be active, and a few new colonies (e.g., Little Sedge Island) appeared, but most of the colonies (e.g., Middle Island)

Table 2. Mean (\pm SE) number of active Herring Gull and Great Black-backed Gull nesting colonies, by decade, on Long Island, New York during 1974-2013.

Decade	Herring Gulls		Great Black-backed Gulls	
	Mean	SE	Mean	SE
1970s	31.8 A ¹	3.37	25.8 A	2.69
1980s	33.8 A	0.66	25.0 A	1.10
1990s	29.2 A	1.49	25.8 A	0.87
2000s	23.0 B	1.58	23.4 A	1.37

¹Decadal means within the same column with the same letter are not significantly different ($P > 0.05$).

fluctuated with regard to the number of estimated nesting pairs but remained active (Fig. 5).

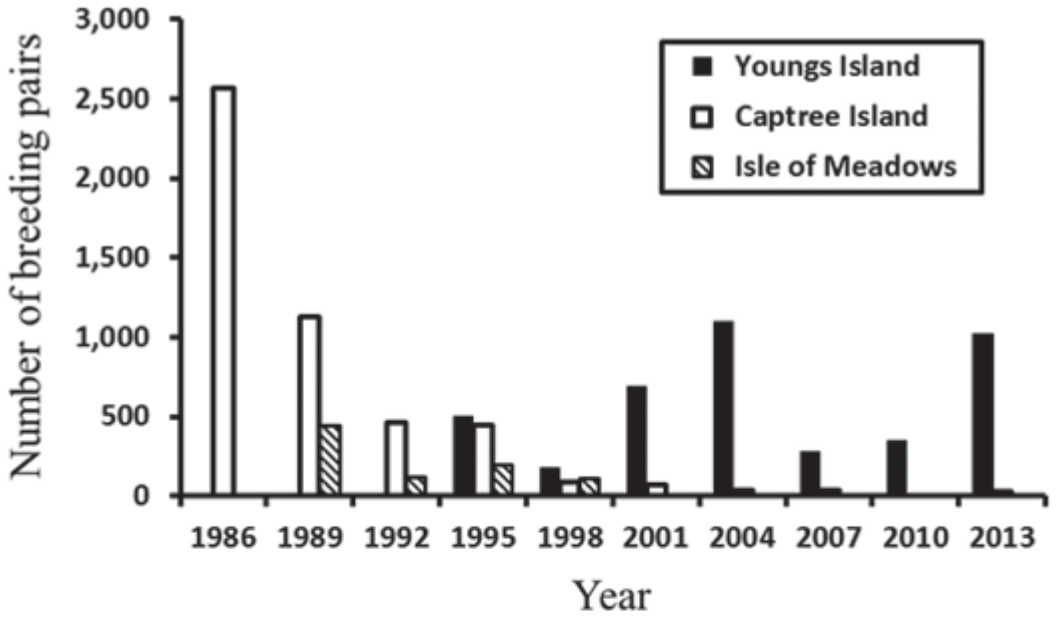
DISCUSSION

Herring and Great Black-backed gull breeding populations in the New York Bight have been dynamic during the past 40 years. Although the highest numbers of breeding pairs of gulls on Long Island occurred during the 1970s and 1980s, these populations appear to have become relatively stable (in both abundance and the number of active colonies) since the mid-1990s. In coastal New Jersey, Herring Gull nesting populations have been stable (with regard to both abundance and the number of nesting colonies) during 1977-2013. In contrast, the number of breeding pairs of Great Black-backed Gulls breeding in New Jersey has steadily increased over the same time period, suggestive of a continuing range expansion southward by this species. Interestingly, many of the Herring and Great Black-backed gull nesting colonies in the New York Bight are associated with mixed-species heronries.

A variety of natural and anthropogenic factors could be influencing the size and distribution of gull nesting populations within the New York Bight. These factors include increased tidal flooding and marsh erosion observed on many marshes and islands since the 1980s (Gornitz *et al.* 2002; Hartig *et al.* 2002), egg/clutch losses due to avian and mammalian predators (Ellis *et al.* 2007), gull management efforts (Belant 1997), changes in waste management systems (Walsh and LaFleur 1995; Washburn 2012), inter-specific competition for nest sites and direct mortality (Buckley and Buckley 1984; Ellis and Good 2006), and high levels of pollutants and contaminants that reduce the water quality (Seidemann 1991; Botton *et al.* 2006).

Changes in water levels, most importantly predicted increases in accelerated sea-level rise and increased storm frequency during the next century, can have significant impacts on coastal shorelines, salt marsh veg-

Herring Gulls



Great Black-backed Gulls

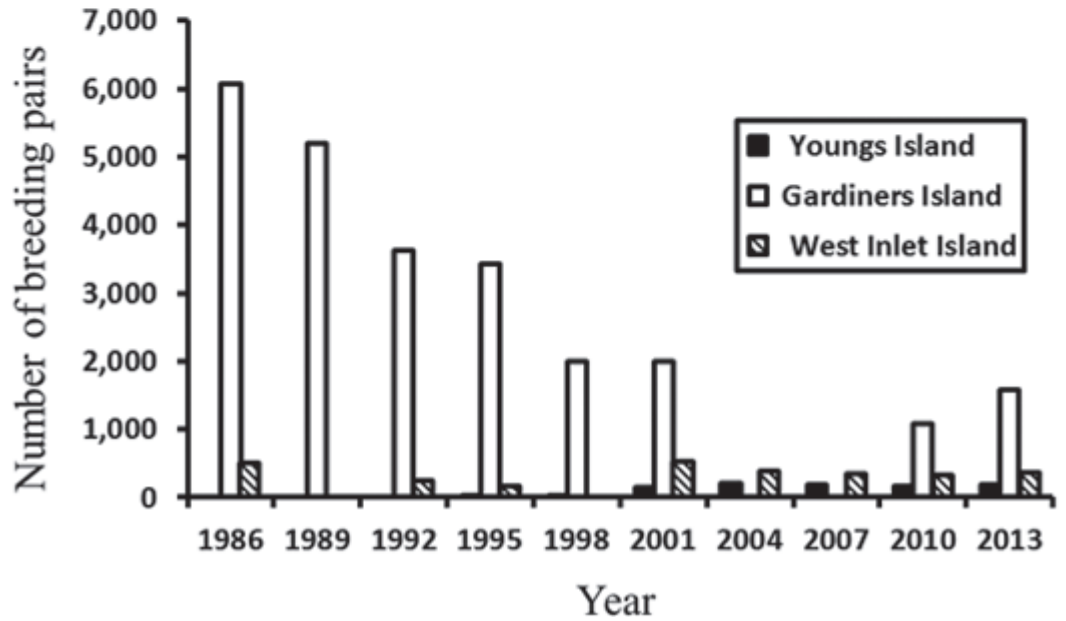


Figure 3. Population trends of Herring Gulls at three nesting colonies and Great Black-backed Gulls at three nesting colonies located on Long Island, New York, during 1986-2013.

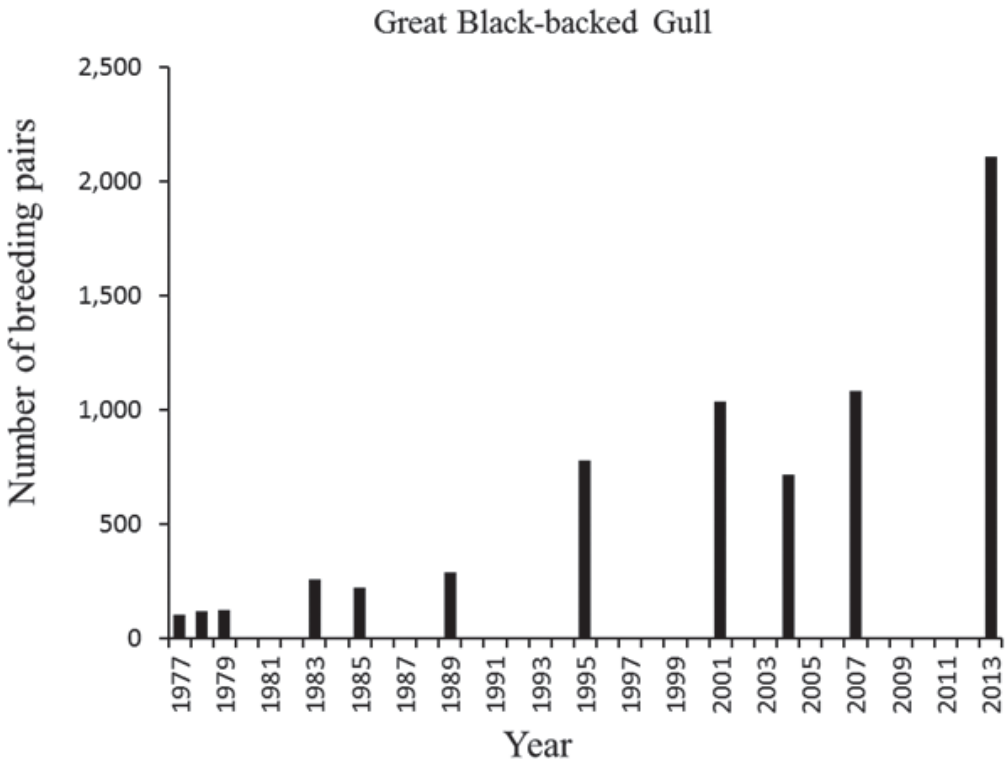
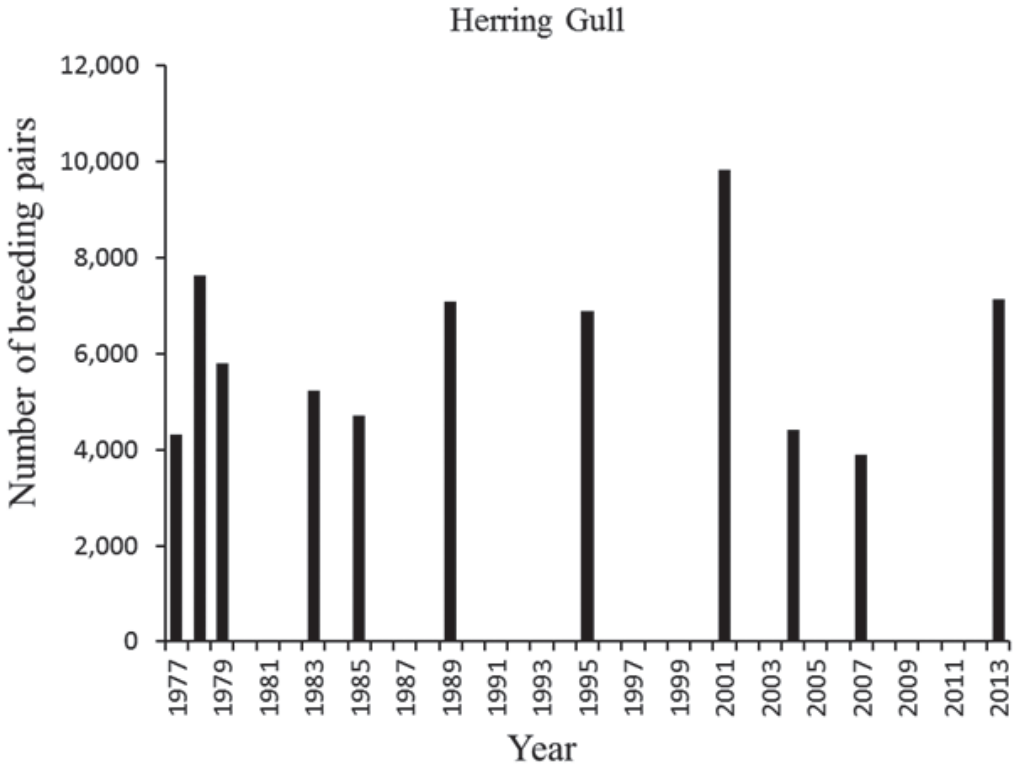


Figure 4. Population trends of Herring Gulls and Great Black-backed Gulls in New Jersey during 1977-2013. All populations are complete censuses of all known colonies expressed as number of breeding pairs.

Table 3. Number of active Herring Gull and Great Black-backed Gull nesting colonies in coastal New Jersey during 1977-2013.

Year	Herring Gulls	Great Black-backed Gulls
1977	34	22
1985	42	33
1995	65	46
2001	58	43
2004	52	35
2007	56	48
2013	58	49

etation and flooding, and other aspects of coastal habitats (Hartig *et al.* 2002; Erwin *et al.* 2006a, 2006b). Alterations in coastal habitats used by colonial nesting waterbirds, such as Herring and Great Black-backed gulls, could significantly influence the local and regional populations of these birds. Furthermore, extreme weather events (e.g., hurricanes, Northeasters) have the potential to completely degrade the coastal shoreline and salt marshes (Gornitz *et al.* 2002; Boger *et al.* 2012) and remove nesting sites for gulls and other colonial waterbirds (Washburn *et al.* 2012). In New York City, there is a notable increase in Herring Gull use of rooftops for nesting (e.g., Riker's Island in the East River and the Farley Building in Manhattan).

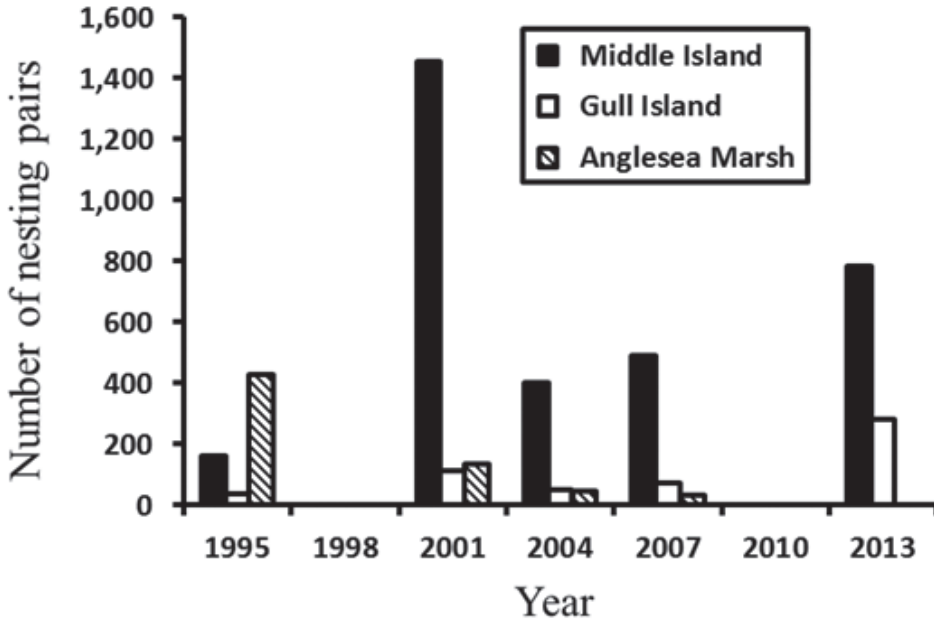
Mammalian predators can quickly have drastic impacts on Laridae nesting colonies (Kadlec 1971; Ellis *et al.* 2007) and probably influence Herring and Great Black-backed gull nesting colonies in the New York Bight. Although active gull nesting colonies have been present on Ruffle Bar Island and Caransie Pol (two islands within Jamaica Bay, New York) since the 1950s (Bull 1964; Buckley and Buckley 1980; Brown *et al.* 2001), these colonies disappeared during the last decade. The lack of any successful gull nesting on Ruffle Bar Island during 2007 and Canarsie Pol since 2010 is likely the result of nest/egg predation by raccoons (*Procyon lotor*), as evidence of predated gull nests and signs of raccoon presence have been documented (Washburn 2010, 2013).

The availability of anthropogenic food sources associated with waste management systems (i.e., landfills) has strongly influ-

enced Herring Gull and Great Black-backed Gull breeding populations in the New York Bight. Landfills can be important foraging locations for these two species (Pierotti and Good 1994; Good 1998). During the 1970s and 1980s, gull nesting populations on Long Island were at their highest levels. During same time period, several large landfills in the New York City portion of Long Island were actively processing putrescible waste (Walsh 1991a, 1991b). However, by 1991 only one active landfill (Fresh Kills Landfill on Staten Island; Walsh and LaFleur 1995) remained; since then waste has been processed using a waste transfer system, which provides less access to avian scavengers (e.g., gulls; Washburn 2012). Drastic declines in Herring and Great Black-backed gull nesting populations occurred following the closure of the landfills, suggesting that such changes in the waste management system were primarily responsible. Other factors, such as declines in marine fish resources and shifting levels of fishery discards associated with commercial fishing, certainly could influence the nesting populations of Herring and Great Black-backed gulls in the New York Bight.

Several factors have the potential to influence (or more importantly bias) estimates of breeding pairs (or nests) within gull colonies during ground or aerial surveys. Seasonal and individual (bird) variation in the amount of time both members of a breeding pair spend at the nest site can be an important issue (Hanssen 1982; Wilson 2013). Also, the presence of juvenile and non-breeding adult gulls in Laridae nesting colonies has the potential to bias (i.e., result in overestimation of) the estimated number of breeding pairs of birds within colonies (Hanssen 1982; Rodgers *et al.* 2005; Green *et al.* 2008; Washburn 2013). For consistency, we assumed a 1:1 adult-to-nesting pair ratio when estimating the number of breeding pairs of Herring and Great Black-backed gulls for our analyses. However, other researchers have used different adult-to-nest ratios when estimating the population of breeding California Gulls (*L. californicus*; Shuford and Ryan 2000), Herring Gulls

Herring Gulls



Great Black-backed Gulls

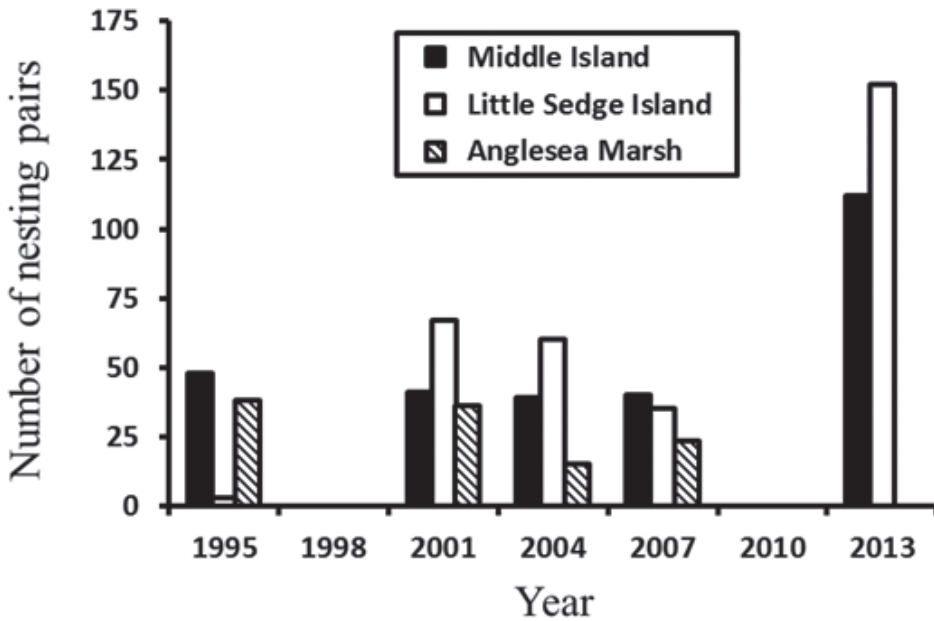


Figure 5. Population trends of Herring Gulls at three nesting colonies and Great Black-backed Gulls at three nesting colonies located in New Jersey during 1995-2013.

(Drury and Kadlec 1974), and Ring-billed Gulls (*L. delawarensis*; Wilson 2013; Wilson *et al.* 2014) within nesting colonies. We believe this is an area of essential research that needs to be completed to allow for a better understanding of these factors and their influence on estimates of colonial waterbird colony size (i.e., nests, breeding pairs).

The findings from this study provide an important baseline for future management decisions regarding the status of and potential management activities for Herring and Great Black-backed gull breeding populations within the New York Bight. Information about the size and distribution of gull nesting colonies is essential to State and Federal wildlife management agencies and other entities involved in the reduction of human-gull conflicts and gull impacts to other birds (e.g., plovers and terns), and with addressing other important issues related to gulls within the New York Bight and more broadly within the northeastern USA.

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