

**Survey of Coastal Nesting Colonies of Cormorants, Gulls,
Night-Herons, Egrets, and Ibises in Massachusetts, 2006-08**

Final Report



**Compiled by Scott M. Melvin
Natural Heritage and Endangered Species Program
Massachusetts Division of Fisheries and Wildlife
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**Cover photo credits (clockwise from upper left): Double-crested Cormorants, Scott Melvin;
Black-crowned Night-Herons, Jack Swedberg; Herring Gulls, Bill Byrne;
Snowy Egret, Dusty Perin**

ABSTRACT

This report summarizes results of a coastwide survey of colonial waterbirds nesting in Massachusetts that was conducted during May and June, 2006-08. Species surveyed included Double-crested Cormorant (*Phalacrocorax auritus*), Great Egret (*Casmerodius albus*), Snowy Egret (*Egretta thula*), Little Blue Heron (*Egretta caerulea*), Cattle Egret (*Bubulcus ibis*), Black-crowned Night-Heron (*Nycticorax nycticorax*), Glossy Ibis (*Plegadis falcinellus*), Laughing Gull (*Larus atricilla*), Herring Gull (*L. argentatus*), and Great Black-backed Gull (*L. marinus*). A total of 96 known or potential colony sites, including all significant colony sites that were surveyed in the last comprehensive survey in 1994-1995, were surveyed during May or June in 2006 or 2007. One additional historic site, Clarks Island in Plymouth, was surveyed by boat on 5 June 2008. Additional counts of roof-nesting gulls at selected sites in 2006 and 2007 were reported pursuant to depredation permits. Surveys at most colonies consisted of total nest counts made by observers on the ground. At small rocky islands that were too steep for safe landings, counts of nests or nesting adults were made by observers in a small boat that slowly circled each island. On South Monomoy Island, Chatham, nest counts were made along systematic transects on all but the northern portion of the island. Mark-recapture nest counts were used to survey gull colonies on Tuckernuck, Muskeget, and Penikese islands. Surveys at most sites used the same methodologies as in the previous Massachusetts survey in 1994-95 so that results would be directly comparable.

Tallied in the 2006-08 survey were 5,963 pairs of Double-crested Cormorants at 31 sites, 9,725 pairs of Herring Gulls at 55 sites, 9,054 pairs of Great Black-backed Gulls at 49 sites, 1,492 pairs of Laughing Gulls at 1 site, 781 pairs of Black-crowned Night-Herons at 15 sites, 401 pairs of Snowy Egrets at 10 sites, 228 pairs of Great Egrets at 6 sites, 144 pairs of Glossy Ibises at 5 sites, 17 pairs of Little Blue Herons at 1 site, and 2 pairs of Cattle Egrets at 1 site. Comparisons of results from sites surveyed with comparable methods in 1994-95 and 2006-08 indicated substantial decreases in numbers of pairs of Double-crested Cormorants (- 19.5 %), Herring Gulls (- 42.2 %), Great Black-backed Gulls (- 40.0%), Black-crowned Night-Herons (- 45.3%) and Snowy Egrets (- 36.0%). Species that had increased in abundance between the 2 survey periods were Laughing Gull (+ 82.6%), Glossy Ibis (+ 193.0 %), and Great Egret (+ 230.4 %).

The substantial declines observed in 5 of these species indicate a need for more intensive monitoring and conservation-oriented research. Recent coastwide surveys in Maine and New Hampshire have documented similar declines in cormorants and the two larger gull species (Welch et. al. 2010). Recommended actions include: 1) more frequent monitoring of breeding populations, i.e., at least every 3 years, 2) research to improve precision, accuracy, and efficiency of surveys, 3) a more thorough assessment of the trends reported in this report in the context of regional trends, and 4) research to identify factors that are influencing state and regional trends in these species. Improved monitoring of breeding cormorant, gull, and wading bird populations is especially warranted given the vulnerability of these species to potential threats posed by sea level rise and climate change.

INTRODUCTION

This report summarizes results of a comprehensive survey of coastal waterbird nesting colonies in Massachusetts conducted during May and June, 2006-08. Survey results are presented for 10 species: Double-crested Cormorant (*Phalacrocorax auritus*), Great Egret (*Casmerodius albus*), Snowy Egret (*Egretta thula*), Little Blue Heron (*E. caerulea*), Cattle Egret (*Bubulcus ibis*), Black-crowned Night-Heron (*Nycticorax nycticorax*), Glossy Ibis (*Plegadis falcinellus*), Laughing Gull (*Larus atricilla*), Herring Gull (*L. argentatus*), and Great Black-backed Gull (*L. marinus*). Previous coastwide surveys of cormorant, gull, and wading bird nesting colonies in Massachusetts were conducted in 1977 (Erwin 1979, Erwin and Korschgen 1979), 1984 (Blodget 1985, Andrews 1990), and 1994-1995 (Blodget and Livingston 1996). Censuses of breeding Roseate Terns (*Sterna dougallii*), Common Terns (*S. hirundo*), Arctic Terns (*S. paradisaea*), Least Terns (*Sternula antillarum*), Laughing Gulls, and Black Skimmers (*Rhynchops niger*) are conducted annually in Massachusetts (see Mostello 2010). The 2006-08 surveys were conducted by over 100 full-time or seasonal biologists, volunteers, and law enforcement staff affiliated with state and federal agencies, municipal governments, private conservation organizations, and colleges. As in 1984 and 1994-95, the Massachusetts Division of Fisheries and Wildlife (MassWildlife) coordinated surveys of cormorant, gull, and wading bird colonies in 2006-08 and compiled results.

A variety of wildlife management issues are associated with colonial waterbirds. For example, questions and concerns have been raised about impacts of Double-crested Cormorants on commercial and recreational fisheries and whether cormorant populations are “overabundant” (U.S. Fish and Wildlife Service 2003, Wires and Cuthbert 2006). Conversely, declines in fish stocks caused by anthropogenic factors such as overfishing (Kurlansky 1997) or climate change could adversely affect local or regional populations of fish-eating seabirds such as cormorants and gulls. Colonial waterbirds may be sensitive indicators of environmental contaminants because they occupy upper trophic levels, use human-influenced environments, and are highly mobile (Kushlan 1993). Various pesticides and heavy metals have been linked to reduced reproductive success or survival in Herring Gulls (Breton et al. 2008), Black-crowned Night-Herons (Davis 1993), and Snowy Egrets (Parsons and Master 2000), and significant levels of dieldrin and dioxin have been found in Herring Gull eggs (Ryckman et al. 2005). On-going management programs directed at gulls seek to reduce competition with, and predation on, terns and other seabirds (Nisbet 1973, 1975; Kress 1998), hazards to aircraft (MacKinnon 2001), or presence at landfills and reservoirs and contamination of drinking water supplies (Belant et al. 1993, Mass. Department of Environmental Protection 1998, Pierotti and Good 1994). In the future, coastal waterbirds and their nesting and feeding habitats are likely to be significantly impacted by the combined effects of sea level rise, climate change, coastal development, and increasing human populations. Conservation actions on behalf of these species are more likely to be effective if guided by reliable and up-to-date data on abundance and distribution of breeding colonies.

OBJECTIVES

Objectives of the 2006-08 survey were to: 1) estimate the abundance of breeding populations of 9 species of colonial-nesting coastal waterbirds in Massachusetts that are not monitored annually, 2) determine the distribution of nesting colonies along the entire Massachusetts coast, and 3) track recent changes in abundance and distribution of these species in Massachusetts by collecting data that would be comparable with those from the last statewide survey in 1994-95. Target species were: Double-crested Cormorant, Great Egret, Snowy Egret, Little Blue Heron, Cattle Egret, Black-crowned Night-Heron, Glossy Ibis, Herring Gull, and Great Black-backed Gull. Count data for Laughing Gulls in 2006 (Mostello 2007) are also included in this report for comparison with 1994-95 survey data.

METHODS

The 2006-08 survey sought to count as completely and accurately as possible numbers of breeding pairs of target species at all known and historic (within the past 30 years) nesting colonies along the Massachusetts coast. Surveys at most sites used the same methodologies as in the previous Massachusetts survey in 1994-95, so that results would be directly comparable. However, at some colonies slightly different count methodologies were used, or we were uncertain if methods were directly comparable with past surveys. Such instances are specifically noted below and in Appendix 1. In this report, comparisons of results from surveys in 1994-5 and 2006-08 are made only for sites where comparable methods were used. For gulls, methodologies that were generally not considered comparable, unless otherwise noted (Appendix 1), were boat-based adult counts versus boat-based nest counts, and boat-based nest counts versus ground-based nest counts. We included in comparisons one-time nest counts made by a line of closely spaced observers walking abreast versus either nest counts using mark-recapture methods (Tuckernuck, Muskeget, and Penikese islands) or subsampling via nest counts along systematically spaced, GPS-located transects (South Monomoy Island). For colonies that were surveyed in both 1994 and 1995 (B.G. Blodgett and J.E. Livingston 1996, unpubl. data, Massachusetts Division of Fisheries and Wildlife, Westborough), the larger of the 2 counts is presented for comparison with 2006-08 results (Appendix 1). Abundance is reported as numbers of pairs for all species in both survey periods.

Survey data were collected at 77 colony sites between 11 May and 13 June 2006 and at 17 sites between 23 May and 5 June 2007. In addition, 2 minor gull nesting sites, Pea Islands in Fairhaven and Big Gravel Island in Oak Bluffs, were surveyed on 20 June 2006 and 1 July 2007, respectively, and a former colony site, Clarks Island in Plymouth, was surveyed by boat on 5 June 2008. Counts of roof-nesting gulls included counts of gull nests removed from 4 Massachusetts Bay Transportation Authority (MBTA) rooftops during April - July 2006, from Boston Fish Pier rooftops during May 2007, and at the Pilgrim Nuclear Power Plant in Plymouth during May-August 2007.

Cormorants and Gulls

At most colonies of Double-crested Cormorants and gulls, direct counts of nests were made for the entire colony. Teams of 2 to 9 observers walked abreast through all areas of suitable habitat and tallied all nests observed, including nests with eggs or hatchlings, as well as empty nests that were well-formed and appeared to have been recently constructed or recently active, i.e., nests in which eggs had not yet been laid or had been lost, or from which chicks had been lost or had recently fledged. At most North Shore (Essex County) colonies, nests were marked on the outside with a small spot of biodegradable paint applied from spray cans mounted on hand-held wands, to prevent double-counting. Observers moved carefully but steadily through colonies in order to complete accurate and thorough counts while minimizing disturbance. Observers were especially mindful of the need to minimize time spent in or near cormorant nesting colonies, in order to minimize disturbance to incubating or attending adults that might facilitate gull predation on eggs or chicks.

On small, rocky islands that were too steep for safe landings, nests or nesting adults were counted from a small boat that slowly circled as close as possible to the island. Numbers of nesting pairs were determined from counts of gulls or cormorants that appeared to be sitting on or standing next to nests. Islands were usually circled twice, the first time to orient observers to the distribution pattern of nesting birds, and the second time to actually make counts. For sites at which boat-based counts were made independently by two or more observers, the largest of the counts is reported. Boat-based nest “counts” in 2006 were considered comparable with boat-based nest “estimates” from the 1994-95 survey.

Ground counts of gull nests on Tuckernuck and Muskeget islands were made using simple mark-recapture methods. Nesting colonies were divided into sections, and observers walked through each section and marked every nest found with a stake (R. Veit, College of Staten Island, pers. comm.). A different observer then walked through each section and recorded all marked and unmarked nests. Total nests for each species were then estimated using the Lincoln-Peterson mark-recapture method (Brower and Zar 1977). On Penikese Island, an island-wide ground count of nests was “corrected” based on mark-recapture estimates derived from three 100 m x 100 m plots (Davis and Mostello 2006).

In mixed nesting colonies of Herring and Great Black-backed Gulls, observers identified nests to species by scanning sections of colonies before they entered them or after they had passed through, to determine which species were attending specific nests. At some sites, observers assigned nests to species based on egg size or a combination of egg size and species of adult showing alarm. Often, sections of colonies were overwhelmingly of one species or the other, which facilitated identification of nests both with and without eggs. For example, on some rocky islands, nests of Herring Gulls and Great Black-backed Gulls were distributed near the shoreline in concentric rings, with Herring Gulls tending to nest in more exposed, seaward locations such as the outer, less vegetated portions of rocky ledges. Nest identity could often be determined by watching

which species returned to a given nest. Egg rings were sometimes used to aid in nest identification in mixed gull colonies. Empty gull nests were attributed to species by: 1) observing the species attendant at the nest, 2) determining the predominant species within clearly segregated sections of a colony, or, 3) determining the observed ratio of adults, or occupied nests that could be confidently identified to species, in mixed-species portions of colonies.

Transect counts were used to subsample the gull colony at South Monomoy Island, Chatham, because of the large numbers of nesting gulls that needed to be surveyed across 519 ha of suitable habitat. On 29 and 30 May 2007, 5 observers walked a total of 254 east-west transects that ranged from 11 to 1,628 m in length and were aligned roughly perpendicular to the main north-south axis of the island and extended across the island from intertidal zone to intertidal zone or ended at unsuitable nesting habitat, such as ponds. Transects were systematically spaced 40 m apart using GPS units. Observers recorded all nests detected within 3 m of either side of the observer, i.e., transects were 6 m wide. Total area surveyed, i.e., total area of transects, was 57 ha or 11% of the total suitable nesting habitat on the island as estimated from recent satellite imagery (S. Koch, U.S. Fish and Wildlife Service, pers. comm.). This percentage was then used to extrapolate estimates of total numbers of Herring Gull and Great Black-backed Gull nests for the entire island. Gulls that nested on North Monomoy Island, and on the north end of South Monomoy Island in areas intensively managed to discourage nesting gulls and encourage nesting by terns, were surveyed by means of total ground counts of nests made by 7-8 closely spaced observers walking abreast through all areas of suitable habitat.

Wading Birds

Counts of wading birds (night-herons, egrets, and ibises) were usually total nest counts. Nests were tallied only if they were deemed to be part of that season's breeding effort, i.e., they contained either eggs or chicks, or were substantial enough and had evidence such as fresh nesting material, white-wash, or feathers to indicate they were not left over from the previous year. Censuses of wading bird colonies were usually led by biologists with considerable experience detecting and counting nests of these species in dense vegetation. Mirrors mounted on poles facilitated nest and egg identification. Where multiple counts were made at a given colony, only the peak count is reported here. Because of the difficulty associated with distinguishing nests and eggs of Little Blue Herons or Cattle Egrets from those of Snowy Egrets, a pooled count of all nests believed to belong to these species was made and then species-specific estimates were derived based on the ratio of adult counts of each species at the colony.

RESULTS

Ninety-six coastal colony sites were surveyed in 2006-07. These included 32 islands along the North Shore (Essex County); 19 islands in Boston Harbor; 8 islands along the South Shore (Norfolk and Plymouth counties); 10 colony sites on Cape Cod; 6 islands in Buzzards Bay (including the Weepecket Islands, a cluster of 3-4 small islands, the actual number being dependent on the tide and one's definition of "island"); 6 sites on Martha's

Vineyard, plus Nomans Land Island, which lies 3 miles to the southwest; 12 sites on Nantucket; and the islands of Tuckernuck and Muskeget situated between Nantucket and Martha's Vineyard (Fig. 1; Appendix 1). One additional former colony site, Clarks Island in Plymouth, was slowly circumnavigated by small boat on 5 June 2008, but no evidence of nesting gulls, cormorants, or wading birds was observed along the shoreline and steep banks of the island or in trees or shrubs along the tops of the banks. In addition, counts of roof-nesting gulls were derived from annual reports of nests destroyed on rooftops of 4 MBTA facilities in Charlestown, Everett, and Medford in 2006, and on rooftops at the Boston Fish Pier in South Boston and the Pilgrim Nuclear Power Plant in Plymouth in 2007, pursuant to depredation permits issued by the U.S. Fish and Wildlife Service, Hadley, Massachusetts.

Double-crested Cormorant – A total of 5,963 pairs of Double-crested Cormorants was tallied at 31 colonies in 2006-08 (Table 1; Appendix 1). Most colonies occurred on islands along the North Shore (17 of 31 colonies, 55%) or in Boston Harbor (7 of 31 colonies, 23%). Colony size ranged from 3 to 1,498 pairs. The largest colonies were on the Weepeeket Islands in Buzzards Bay (1,498 pairs), Middle Brewster Island in Boston Harbor (772 pairs), Nomans Land (630 pairs), and Milk Island in Rockport (592 pairs). Although no breeding Great Cormorants (*Phalacrocorax carbo*) were reported, four 1-year-old birds were observed on Green Island in Boston Harbor on 25 May 2006 (reported by R. Veit and K. Parsons), and an immature bird was observed at Tinker's Island, Salem, on June 9, 2006 (reported by J. Berry).

Double-crested Cormorants declined by 19.5%, from 6,375 to 5,134 pairs, between 1994-95 and 2006-08, based on counts from 27 of 35 sites (77%) that were surveyed using comparable methods (Tables 1, 8; Fig. 2). Of the 27 comparable colonies, 12 declined in numbers between survey periods, 7 increased, and 8 were essentially unchanged (changed by ≤ 15 pairs). Three of the 4 largest colonies in 2006-08 (Weepeeket Islands, Milk Island, and Middle Brewster Island) had collectively declined by 976 pairs or 25.4% compared to the 1994-95 survey, while Nomans Land Island had increased from 392 to 630 pairs (60.7%). Three sites with nesting cormorants in 1994-95 were unoccupied in 2006-08, while 7 sites that were unoccupied in 1994-95 supported nesting cormorants in 2006-08. At 5 of 6 sites where non-comparable count methods were used between census periods, numbers of pairs were lower in 2006-08 than in 1994-95. Two small colonies were only surveyed in one of the survey periods: the Provincetown Harbor breakwater (15 pairs in 1994-95) and the Nantucket Harbor jetties (24 pairs in 2006).

Herring Gull – In the 2006-08 survey, 9,725 pairs of Herring Gulls were tallied at 55 colonies (Table 2; Appendix 1). An estimated < 40 nesting pairs were also present on the ferry terminal building at the state pier in New Bedford, but a complete count was not made. Statewide, colonies ranged in size from 1 to 1,372 pairs. Nearly two-thirds of colonies occurred on islands along the North Shore (24 colonies, 43.6%) or in Boston Harbor (11 colonies, 20%). However, the 3 largest colonies in the state were on South Monomoy Island (1,372 pairs) and North Monomoy Island (1,354) in Chatham on Cape Cod, and on Penikese Island in Buzzards Bay (1,049). The next 5 largest colonies were

Thatcher Island, Rockport (855 pairs), Nomans Land (375 pairs estimated), Coskata-Coatue, Nantucket (374), Middle Brewster Island, Boston (364), and Milk Island, Rockport (340).

Herring Gulls declined by 42.2%, from 15,812 to 9,143 pairs, between 1994-95 and 2006-08 surveys, based on comparable counts at 54 of 73 (74%) sites surveyed (Tables 2, 8; Fig. 2). Of these comparable sites, 14 declined in numbers between census periods, 4 increased, and 8 were essentially unchanged (number of pairs changed by ≤ 10 pairs). Note that in this report we have considered the counts of gulls at South Monomoy Island to be comparable between survey periods, even though different methods were used.

In 1994-95, a total of 643 pairs of Herring Gulls were counted on rooftops at 4 MBTA sites near the Mystic River in Charlestown, Everett, and Medford; on rooftops adjacent to the Boston Fish Pier in Boston; at the Dorchester gas tanks, Boston, a warehouse in Squantum, Quincy, the Pilgrim Nuclear Power Station, Plymouth, the Com Gas Electric Plant, New Bedford, and the state pier, New Bedford. These sites were not directly surveyed in 2006-08 because of uncertainty as to exact locations (Boston Fish Pier rooftops), safety issues that prevented access (ComGas electric plant), or lack of time. However, records of gull nests destroyed by staff of U. S. Department of Agriculture-Wildlife Services, pursuant to depredation permits issued by U.S. Fish and Wildlife Service, provided counts of Herring Gull nests at the Mystic River MBTA sites and at the Pilgrim Nuclear Power Station. Numbers had declined substantially at the MBTA sites, from 239 to 23 pairs, and were essentially unchanged (20 versus 22 pairs) at the Pilgrim Station. Observations from the ground suggested that numbers of Herring Gulls nesting on the roof of the ferry terminal at the state pier in New Bedford were similar or slightly less than the 45 pairs counted in 1994-95. A review of reports filed with U.S. Fish and Wildlife as a condition of permitted destruction of eggs and nests on rooftops at other locations indicated that Herring Gulls nested at several other urban rooftop sites in 2006, but their numbers were too small to suggest a shift in nesting distribution that could account for the large statewide decrease since the 1994-95 census. Given these results and efforts by USDA-Wildlife Services in recent years to discourage gulls from nesting on rooftops, it seems unlikely that rooftop-nesting gulls accounted for a larger proportion of the state's breeding population in 2006-08 than in 1994-95.

Great Black-backed Gull - In the 2006-08 survey, 9,054 pairs of Great Black-backed Gulls were tallied at 49 colonies (Table 3; Appendix 1). Statewide, colonies ranged in size from 1 to 3,152 pairs. Two-thirds of the colonies were on islands off the North Shore (22 colonies, 44.9 %) or in Boston Harbor (10 colonies, 20.4 %). However, the 3 largest colonies in the state were on South Monomoy Island, Chatham (3,152 pairs), Muskeget Island, Nantucket (1,140), and North Monomoy Island, Chatham (741). The next largest colonies were at Coskata-Coatue, Nantucket (654), Tuckernuck Island (370), Milk Island, Rockport (591), and Thatcher Island, Rockport (344).

Great Black-backed Gulls declined by 40.0% between 1994-95 and 2006-08, from 14,616 to 8,774 pairs, based on counts at 56 of 71 (79%) sites that were surveyed using comparable methods (Tables 3, 8; Fig. 2). Of the 56 sites with comparable data, numbers

declined at 27, increased at 7, and were essentially unchanged at 22 (number of pairs changed by ≤ 10 pairs).

In 1994-95, a total of only 48 pairs of Great Black-backed Gulls were counted on rooftops at 4 MBTA sites near the Mystic River in Charlestown, Everett, and Medford, on rooftops near the Boston Fish Pier and the state pier in New Bedford, at the Dorchester gas tanks in Boston, on a warehouse in Squantum, Quincy, and at the Pilgrim Nuclear Power Station, Plymouth, suggesting that these anthropogenic habitats are used for nesting by Great Black-backed Gulls less frequently than by Herring Gulls. Depredation permit reports filed by USDA-Wildlife Services indicated no nesting Great Black-backed Gulls in 2006 at the MBTA sites near the Mystic River or at the Pilgrim Nuclear Power Plant in Plymouth, compared to 11 and 3 pairs reported at those sites in 1994-95 (Table 3).

Laughing Gull – In 2006, only a single colony of 1,492 pairs of Laughing Gulls was present in Massachusetts, at South Monomoy Island, Chatham (Mostello 2007). In 2007, the number of Laughing Gull colonies increased to 3: South Monomoy Island (1,512 pairs), Minimoy Island, Chatham (14), and Plymouth Beach (59) (Mostello 2008). The 2007 total of 1,585 pairs was an 82.6% increase over the 1994 total of 868 pairs that were present at 3 sites: New Island, Orleans/Eastham (832 pairs), Nauset Spit (“Plover Island”), Eastham (26), and Plymouth Beach (10) (Table 8). The large colonies of Laughing Gulls and Common Terns at New Island during the 1990’s subsequently collapsed in 2001 and 2002 as the natural westward migration of Nauset Spit eventually created a land bridge that allowed easy access by mammalian predators to the island at low tide.

Egrets, Night-Herons, and Ibises - Fifteen sites supported nesting pairs of Great Egret, Snowy Egret, Little Blue Heron, Cattle Egret, Black-crowned Night-Heron, or Glossy Ibis (Appendix 1). Nine of these sites supported mixed breeding colonies of 2 or more of these species: Kettle Island, Gloucester; Eagle Island, Salem; Outer Brewster Island, Boston; Sheep Island, Weymouth; Sarah Island, Hingham; North Monomoy Island, Chatham; South Monomoy Island, Chatham; Penikese Island, Gosnold; and Coskata-Coatue, Nantucket. Of the 6 species of waders, Black-crowned Night-Heron was most numerous with 781 pairs, followed by Snowy Egret (401), Great Egret (228), Glossy Ibis (144), Little Blue Heron (17), and Cattle Egret (2) (Tables 4-7; Appendix 1). Cattle Egrets were reported nesting at only one site, Eagle Island, Salem, and Little Blue Herons were reported nesting only at Kettle Island, Gloucester (Appendix 1). Comparisons of results from sites surveyed with comparable methods in 1994-95 and 2006-08 indicated substantial decreases in numbers of pairs of Snowy Egrets (- 36%) (Tables 5, 8) and Black-crowned Night-Herons (- 45%) (Tables 6, 8). In contrast, numbers of pairs of the less abundant Great Egret more than tripled and Glossy Ibis nearly tripled (Tables 4, 7, 8). Noteworthy changes between 1994-95 and 2006-08 included the disappearance of mixed-species colonies at Dead Neck-Sampsons Island, Barnstable, and at Cape Pogue on Chappaquiddick Island; large declines in Snowy Egrets, Great Egrets, and Black-crowned Night-Herons at Middle Brewster Island in Boston Harbor and Snowy Egrets and Black-crowned Night-Herons at Sarah Island in Hingham; large increases in Great

Egrets and Glossy Ibises at Kettle Island, Gloucester; and the colonization of Penikese Island in Buzzards Bay by Great Egrets, Snowy Egrets, and Glossy Ibises.

DISCUSSION

Comparisons between surveys

Results from some sites are not perfectly comparable between survey periods due to differences in survey methods or timing. We endeavored to design, time, and conduct surveys in 2006-08 so that results would be comparable with the 1994-95 surveys. We omitted from comparisons sites for which we believe survey methods were too dissimilar between survey periods to be reliably compared. The facts that changes were so large for most species and declining trends were observed at most colonies for Double-crested Cormorant, Herring Gull, Great Black-backed Gull, and Black-crowned Night-Heron further suggest that the direction and relative magnitude of trends are accurate.

Counts of breeding colonial waterbirds will inevitably be biased to some degree by different observers and by slight differences between survey methodologies or timing. Presumably even during peak nesting periods within a year, numbers of nests or nesting pairs within a given colony do not remain constant from week to week. Accordingly, readers should be more confident of broad patterns and overall trends indicated by these results than of apparent small changes at specific sites.

Although roof-top gull colonies surveyed in 1994-95 were not directly re-surveyed in 2006-08, counts of nests destroyed by control efforts at a subset of these sites in 2006 or 2007 indicated that numbers of nesting gulls at these sites had declined between survey periods. This suggests that overall declines in abundance of Herring Gulls and Great Black-backed Gulls observed between 1994 -95 and 2006-08 were not due to a wide-scale shift to nesting on rooftops.

Declining species need conservation attention

The large declines in counts of Herring Gulls (- 42%), Black-crowned Night-Herons (- 45%), Great Black-backed Gulls (- 40%), Snowy Egrets (- 36%), and Double-crested Cormorants (-20%) between 1994-95 and 2006-08 surveys are cause for concern and indicate a need for increased conservation attention for all of these species (Table 8; Figs. 2, 3). These concerns are heightened by the fact that Massachusetts' breeding populations of these species are relatively small, given the state's extensive coastline and abundant and diverse nesting and feeding habitats. It is startling to realize, for example, that the Herring Gull, generally considered to be abundant and ubiquitous along the Massachusetts coast, now numbers less than 10,000 breeding pairs and is apparently one of the fastest declining species of breeding birds in the state.

Recent coastwide surveys of cormorant and gull colonies in Maine and New Hampshire have documented declining trends similar to those in Massachusetts. Between surveys in 1996 and 2008, Double-crested Cormorants declined by 45%, Herring Gulls by 30%, and Great Black-backed Gulls by 42% (Welch et. al. 2010).

Increased attention to monitoring breeding populations of cormorants, gulls, and coastal wading birds is also warranted given their likely vulnerability to threats posed by sea level rise and climate change. Most nesting colonies of these species occur near the shorelines of islands, beaches, and sand spits. The areal extent, morphology, and other habitat features of these shorelines will be modified by rising sea levels. On rocky islands, nesting colonies may be able to “adapt” by gradually shifting upslope to slightly higher elevations. For gulls and cormorants, management by cutting, burning, or herbicide treatments to create or maintain sparse herbaceous vegetation or unvegetated substrates in place of trees or dense shrubs may enhance such adaptation and facilitate colony persistence. Population monitoring is essential in order to inform such management and assess its effectiveness. Many of these islands, however, are so small that birds are already nesting all over them, so any significant loss of area above high tide will represent a net loss of nesting habitat. Many colonies are located on sandy substrates that will be particularly vulnerable to erosive effects of sea level rise, especially if combined with increasing storm frequency. Increasing storm frequency could increase rates and magnitude of shoreline modification and retreat, and could also reduce reproductive success of coastal waterbirds through increased nest flooding or chick mortality if storm frequency increases during the April to July breeding season. How effects of climate change on marine environments (e.g., changes in water temperature, salinity, currents, prey species, and food chains) will affect, in turn, colonial waterbirds is uncertain. Declines in salt marsh habitat caused by sea level rise and the inability of marshes to migrate landward because of human development and “armored” coastlines will mean decreased foraging habitat for wading birds.

Double-crested Cormorants and Herring Gulls may be especially vulnerable to sea level rise because they often nest along shoreline edges. In Massachusetts, most cormorant colonies and many of the Herring Gull nests on rocky islands are in relatively exposed locations along the edges of islands, just above the reach of normal high tides. The largest cormorant colony in the state, on the Weepecket Islands, occurs on small islands composed primarily of glacial till that will be vulnerable to erosion from rising sea level. At many colony sites, Great Black-backed Gulls nest upslope of Herring Gulls and Double-crested Cormorants, often in less exposed, slightly higher sites. Where they nest sympatrically, Great Black-backed Gulls compete with Herring Gulls for nest sites and may prey upon both eggs and young chicks of both species and may impede the ability of breeding cormorants and Herring Gulls to shift their nest sites and colony locations in response to rising sea levels and coastal erosion and inundation.

Recommendations for future surveys

Effective population monitoring is essential to guide and evaluate any future management efforts directed at cormorants, gulls, and wading birds in Massachusetts.

Recommendations include: 1) more frequent monitoring of breeding populations, i.e. at least every 3 years; 2) research to improve precision, accuracy, and efficiency of surveys; 3) research to identify the most important factors influencing state and regional population trends; 4) assessment of statewide trends in the context of regional trends.

Declines of 20 to 45% in breeding populations of 5 target species in just 12 years (Table 8) demonstrate the need for more frequent monitoring than the 10-12 year intervals that have characterized statewide surveys over the past 30 years (Erwin 1979, Blodget 1985, Andrews 1990, Blodget and Livingston 1996). It may be possible to increase the frequency and efficiency of future surveys by surveying a large subsample of both known and historic or potential colony sites. However, sampling must be designed so as to adequately track not only changes in absolute or relative abundance of species, but also changes in colony distribution. Aerial surveys or counts made from aerial photos (Schauffler 1998, Johnson and Krohn 2001) may prove to be more efficient at tracking trends in abundance and distribution of some species than are ground or boat-based surveys (but see Nisbet 2001). By better standardizing the timing of surveys, applying species- and habitat-specific detection probabilities, and working to reduce observer bias, we can likely increase the precision of future survey data and therefore enable more reliable detection of changes in abundance and distribution of breeding colonial waterbirds over time (Steinkamp et. al. 2003). For gulls, detection probabilities should be habitat-specific; gull nests on open rocky ledges and cobble beaches along the edges of small islands likely have higher detection probabilities than nests on larger sandy islands and sandspits with dense herbaceous or shrub cover. On small rocky islands, ground counts of nests are likely more accurate than counts of nests or nesting pairs made from boats. Improved standardization in the timing of surveys should also be an objective, in order to count when maximum numbers of nests are present.

Although we attempted to survey all known or historical (occupied within the past 30 years) nesting sites for target species along the Massachusetts coast, it is possible that we missed some colonies. However, coastal areas of Massachusetts are intensively surveyed each year during May, June, and July by biologists engaged in monitoring and protection efforts for terns, Piping Plovers, and American Oystercatchers at over 200 sites (Mostello 2010, Melvin 2010a, 2010b), and are frequented by recreational birders. This high annual level of field activity probably decreased the likelihood that additional colony sites went undetected during the 2006-08 surveys. If nesting sites were missed, they were most likely relatively small colonies of wading birds that were difficult to observe because of their location in dense shrubs or low trees. Readers who know or suspect the locations of other nesting colonies are encouraged to report this information to MassWildlife, so that these sites can be visited during future surveys.

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Table 1. Double-crested Cormorant colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08.

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
North Shore		
Dry Salvages, Rockport	19	4
Thatcher Island, Rockport	0	3
Milk Island, Rockport	1,081	592
Normans Woe, Gloucester	199	161
Graves Island, Manchester	0	42
Great Egg Rock, Manchester	124	40
Rock Dundy, Manchester	0	12
Chubb Island, Beverly	0	6
Coney Island, Salem	66	64
Great Haste Island, Salem	7	0
Eagle Island, Salem	0	13
North Gooseberry Island, Salem	70	94
South Gooseberry Island, Salem	92 ^a	50 ^a
Cat Island, Salem	34	0
Cormorant Rock, Salem	234	139
Marblehead Rock, Marblehead	14	21
Grays Rock, Marblehead	152	15
Ram Island, Marblehead	0	190
Egg Rock, Nahant	436	138
Boston Harbor		
Green Island, Boston	393 ^b	90 ^b
Little Calf Island, Boston	189 ^a	147 ^a
Outer Brewster Island, Boston	90 ^a	60 ^a
Middle Brewster Island, Boston	878	772
Shag Rocks, Boston	290 ^a	96 ^a
Sheep Island, Weymouth	0	15
Sarah Island, Hingham	17	155
South Shore		
Black Rocks, Hull	39 ^a	68 ^a
Brush Island, Cohasset	747 ^a	384 ^a
Clarks Island, Plymouth	21	0

Table 1. Double-crested Cormorant colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08 (continued).

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
Cape Cod		
Breakwater, Provincetown	15 ^a	nd ^a
Buzzards Bay		
Weepecket Islands, Gosnold	1,878	1,498
Angelica Rock, Fairhaven	130	186
Martha's Vineyard		
Sarson Island, Oak Bluffs	230	254
Nomans Land, Chilmark	392	630
Nantucket		
Harbor jetties, Nantucket	nd ^a	24 ^a
Total pairs, all sites	7,837	5,963
Total pairs, comparable sites	6,375	5,134

^a Counts at these sites are not directly comparable between survey periods because of the disparity in survey methods used in each period or because the site was not surveyed during one of the periods.

^b At Green Island, different count methods were used during the two survey periods: a nest count by observers on the ground in 1994 versus a nest count by boat in 2006. However, because the island is so small and can be approached so closely by boat, and because so few cormorants were present in 2006, observers in that year felt that most, if not all, nests could be readily observed by boat and that their results could be compared confidently with the ground count of nests made in 1994.

Table 2. Herring Gull colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08.

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
North Shore		
Chaces Island, Newbury	1 ^a	nd ^a
Straitsmouth Island, Rockport	23	0
Thatcher Island, Rockport	1,359	855
Milk Island, Rockport	533	340
Tenpound Island, Gloucester	75	13
Normans Woe, Gloucester	76	73
Kettle Island, Gloucester	388	226
Graves Island, Manchester	97	76
Great Egg Rock, Manchester	0	9
Rock Dundy, Manchester	23 ^a	2 ^a
Chubb Island, Beverly	10	28
Great Misery Island, Beverly	0 ^a	1 ^a
Little Misery Island, Beverly	0	1
Bakers Island, Salem	0	75
Coney Island, Salem	158	94
Pope Head, Salem	4	0
Great Haste Island, Salem	57	11
Eagle Island, Salem	166	90
North Gooseberry Island, Salem	43	22
South Gooseberry Island, Salem	40 ^a	17 ^a
Cat Island, Salem	136	260
Cormorant Rock, Salem	7	14
Tinkers Island, Salem	116	189
Marblehead Rock, Marblehead	79	17
Grays Rock, Marblehead	0	2
Ram Island, Marblehead	152	256
Egg Rock, Nahant	107 ^a	68 ^a
Boston/Boston Harbor		
Mystic River MBTA sites	239	22
Green Island, Boston	206 ^b	30 ^b
Calf Island, Boston	352	197
Outer Brewster Island, Boston	329	215
Middle Brewster Island, Boston	700	364
Great Brewster Island, Boston	398	157
Gallops Island, Boston	118	82
Boston Fish Pier rooftops, Boston	9 ^a	9 ^a

Table 2. Herring Gull colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08 (continued).

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
Boston/Boston Harbor (continued)		
Dorchester gas tanks, Boston	131 ^a	nd ^a
Hangman Island, Quincy	4 ^a	7 ^a
Squantum Warehouse, Quincy	105 ^a	nd ^a
Sheep Island, Weymouth	273	243
Sarah Island, Hingham	224	215
Ragged Island, Hingham	4	1
Langlee Island, Hingham	2	0
Button Island, Hingham	1	8
South Shore		
Black Rocks, Hull	273 ^a	28 ^a
Brush Island, Cohasset	136 ^a	72 ^a
Gull Island, Scituate	44	0
Clarks Island, Plymouth	411	0
Plymouth Long Beach, Plymouth	150	1
Pilgrim Nuclear Power Station, Plymouth	22	20
Cape Cod		
Dead Neck-Sampson's Is., Barnstable	769	0
North Monomoy Island, Chatham	1,252	1,354
South Monomoy Island, Chatham	3,963	1,372
Long Point/Wood End, Provincetown	464	0
Buzzards Bay		
Weepecket Islands, Gosnold	245	209
Cedar Island, Naushon Island, Gosnold	1 ^a	nd ^a
Nashawena Island, Gosnold	0 ^a	nd ^a
Penikese Island, Gosnold	759	1,049
Bird Island, Marion	4	0
Pea Island, Fairhaven	nd ^a	2 ^a
Angelica Rock, Fairhaven	218	99
ComGas Electric Plant, New Bedford	92 ^a	nd ^a
State Pier, New Bedford	45 ^a	"present" ^a
Barneys Joy /Allens Pond, Dartmouth	0	0

Table 2. Herring Gull colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08 (continued).

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
Martha's Vineyard		
Cape Pogue Elbow, Edgartown	3	0
Big Gravel Island, Oak Bluffs	nd ^a	1 ^a
Sarson Island, Oak Bluffs	90	28
Haystack Point, Edgartown	0 ^a	nd ^a
Nomans Land, Chilmark	886	375 ^c
Nantucket		
Great Point, Nantucket	24	147
Coskata-Coatue, Nantucket	278	374
Smith Point (Esther Island), Nantucket	0	3
Tuckernuck Island, Nantucket	579	180
Muskeget Island, Nantucket	212	122
Total pairs, all sites	17,665	9,725
Total pairs, comparable sites	15,812	9,143

^a Counts at these sites are not directly comparable between survey periods because of disparities in methods used or because the site was not surveyed during one of the periods.

^b At Green Island in Boston Harbor, the boat-based nest count in 2006 was considered comparable with the ground count of nests in 1994. Observers believed that most, if not all, nests could be readily observed during the 2006 census without landing on the island because the island is so small and can be circled so closely by boat and because so few gulls were present in 2006.

^c At Nomans Land, Chilmark, a complete gull survey was not carried out in 2006-08 because of inclement weather, constraints in time and numbers of observers, and safety concerns about unexploded ordinance (S. Koch, U.S. Fish and Wildlife Service, pers. comm.). Casual observations in those years estimated 500 (\pm 200) nesting pairs of gulls on the island, with \leq 75% of those being Herring Gulls and the rest Great Black-backed Gulls. Observers were of the opinion that numbers of nesting gulls had declined on the island over the previous 10 years.

Table 3. Great Black-backed Gull colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08.

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
North Shore		
Straitsmouth Island, Rockport	143	22
Thatcher Island, Rockport	549	344
Milk Island, Rockport	1,070	591
Tenpound Island, Gloucester	70	40
Normans Woe, Gloucester	4	12
Kettle Island, Gloucester	146	121
Graves Island, Manchester	74	48
Great Egg Rock, Manchester	2	6
Rock Dundy, Manchester	3 ^a	0 ^a
Ram Island, Manchester	2	3
Chubb Island, Beverly	59	33
Great Misery Island, Beverly	0	1
Bakers Island, Salem	0	7
Coney Island, Salem	25	51
Pope Head, Salem	1	0
Great Haste Island, Salem	1	0
Eagle Island, Salem	54	30
North Gooseberry Island, Salem	71	36
South Gooseberry Island, Salem	31 ^a	33 ^a
Cat Island, Salem	281	146
Cormorant Rock, Salem	5	4
Tinkers Island, Salem	0	10
Marblehead Rock, Marblehead	30	3
Ram Island, Marblehead	80	84
Egg Rock, Nahant	49 ^a	11 ^a
Boston/Boston Harbor		
Mystic River MBTA sites	11	0
Green Island, Boston	111 ^b	20 ^b
Little Calf Island, Boston	8	0
Calf Island, Boston	152	63
Outer Brewster Island, Boston	333	55
Middle Brewster Island, Boston	114	96
Great Brewster Island, Boston	12	16
Gallops Island, Boston	8	29
Boston Fish Pier rooftops, Boston	1 ^a	0 ^a

Table 3. Great Black-backed Gull colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08 (continued).

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
Boston/Boston Harbor (continued)		
Dorchester gas tanks, Boston	9 ^a	nd ^a
Hangman Island, Quincy	61 ^a	42 ^a
Squantum Warehouse, Quincy	22 ^a	nd ^a
Sheep Island, Weymouth	6	23
Sarah Island, Hingham	31	40
Ragged Island, Hingham	2	0
Langlee Island, Hingham	2	0
Button Island, Hingham	1	8
South Shore		
Black Rocks, Hull	36 ^a	5 ^a
Brush Island, Cohasset	51 ^a	60 ^a
Gull Island, Scituate	2	0
Clarks Island, Plymouth	209	0
Plymouth Long Beach, Plymouth	10	0
Pilgrim Nuclear Power Station, Plymouth	3	0
Cape Cod		
Dead Neck-Sampsons Island, Barnstable	147	0
North Monomoy Island, Chatham	415	741
South Monomoy Island, Chatham	6,946	3,152
Long Point/Wood End, Provincetown	82	0
Buzzards Bay		
Weepecket Islands, Gosnold	273	217
Cedar Island, Naushon Island, Gosnold	0 ^a	nd ^a
Nashawena Island, Gosnold	6 ^a	nd ^a
Penikese Island, Gosnold	42	86
Bird Island, Marion	5	5
Angelica Rock, Fairhaven	54	18
State Pier, New Bedford	1 ^a	nd ^a
ComGas Electric Plant, New Bedford	0 ^a	nd ^a
Barneys Joy/Allens Pond, Dartmouth	1	0

Table 3. Great Black-backed Gull colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08 (continued).

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
Martha's Vineyard		
Cape Pogue Elbow, Edgartown	173	171
Big Gravel Island, Oak Bluffs	nd ^a	4 ^a
Sarson Island, Oak Bluffs	30	58
Haystack Point, Edgartown	1 ^a	nd ^a
Nomans Land, Chilmark	287	125 ^c
Nantucket		
Great Point, Nantucket	9	119
Coskata-Coatue, Nantucket	812	654
Smith Point (Esther Island), Nantucket	0	101
Tuckernuck Island, Nantucket	451	370
Muskeget Island, Nantucket	1,494	1,140
Total pairs, all sites	15,174	9,054
Total pairs, comparable sites	14,616	8,774

^a Counts at these sites are not directly comparable between survey periods because of disparities in methods used or because the site was not surveyed during one of the periods.

^b At Green Island in Boston Harbor and Gull Island off Scituate, boat-based nest counts in 2006 were considered comparable with the ground counts of nests in 1994 and 1995. Observers believed that most, if not all, nests could be readily observed during the 2006 censuses without landing on the islands because the islands are so small and can be circled so closely by boat and because so few gulls were present in 2006.

^c At Nomans Land, Chilmark, a complete gull survey was not carried out in 2006-08 because of inclement weather, constraints in time and numbers of observers, and safety concerns about unexploded ordinance (S. Koch, U.S. Fish and Wildlife Service, pers. comm.). Casual observations in those years estimated 500 (\pm 200) nesting pairs of gulls on the island, with \leq 75% of those being Herring Gulls and the rest Great Black-backed Gulls. Observers were of the opinion that numbers of nesting gulls had declined on the island over the past 10 years.

Table 4. Great Egret colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08.

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
North Shore		
Kettle Island, Gloucester	42	102
Eagle Island, Salem	0	16
Boston Harbor		
Middle Brewster Island, Boston	8	0
Sarah Island, Hingham	1	76
Cape Cod		
Dead Neck-Sampsons Island, Barnstable	7	0
South Monomoy Island, Chatham	0	1
Buzzards Bay		
Penikese Island, Gosnold	0	7
Nantucket		
Coskata-Coatue, Nantucket	11	26
Total pairs, all sites	69	228
Total pairs, comparable sites	69	228

Table 5. Snowy Egret colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08.

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
North Shore		
Kettle Island, Gloucester	207	231
Eagle Island, Salem	16	10
Boston Harbor		
Outer Brewster Island, Boston	5	14
Middle Brewster Island, Boston	207	23
Sheep Island, Weymouth	0	6
Sarah Island, Hingham	148	49
Cape Cod		
Dead Neck-Sampson's Is., Barnstable	38	0
North Monomoy Island, Chatham	0	2
South Monomoy Island, Chatham	69	37
Buzzards Bay		
Penikese Island, Gosnold	0	37
Martha's Vineyard		
Cape Pogue Elbow, Edgartown	25	0
Nomans Land, Chilmark	13	0 ^a
Nantucket		
Coskata-Coatue, Nantucket	31	47
Total pairs, all sites	627	401
Total pairs, comparable sites	627	401

^a Although comprehensive searches for Snowy Egret nests were not done at Nomans Land in 2006-2008, no Snowy Egrets were observed anywhere on the island during visits in May, June, and July of those years.

Table 6. Black-crowned Night-Heron colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08.

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
North Shore		
Thatcher Island, Rockport	1	0
Tenpound Island, Rockport	0	9
Kettle Island, Gloucester	7	35
Coney Island, Salem	2	0
Eagle Island, Salem	86	53
Boston Harbor		
Calf Island, Boston	1	28
Outer Brewster Island, Boston	25	38
Middle Brewster Island, Boston	207	23
Gallops Island, Boston	38	0
Peddocks Island, Hull	2	0
Sheep Island, Weymouth	14	4
Sarah Island, Hingham	547	343
Cape Cod		
Dead Neck-Sampsons Is., Barnstable	73	0
North Monomoy Island, Chatham	0	6
South Monomoy Island, Chatham	201	152
Long Point/Wood End, Provincetown	7	0
Buzzards Bay		
Penikese Island, Gosnold	18	19
Martha's Vineyard		
Cape Pogue Elbow, Edgartown	60	0
Nomans Land, Chilmark	75 ^a	“present”, ^{a, b}
Nantucket		
Coskata-Coatue, Nantucket	99	60
Tuckernuck Island, Nantucket	40	8
Muskeget Island, Nantucket	0	3
Total pairs, all sites	1,503	781
Total pairs, comparable sites	1,428	781

Table 6. Black-crowned Night-Heron colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08 (continued).

^a Counts at these sites are not directly comparable between survey periods because different methods were used in each period or, in some instances, the site was not surveyed during one of the periods.

^b At Nomans Land in 2008, an incomplete survey of Black-crowned Night-Herons found 3 nests.

Table 7. Glossy Ibis colony sites and counts of nesting pairs in Massachusetts, 1994-95 and 2006-08.

Region, Colony Name, Town	<u>No. pairs</u>	
	1994-95	2006-08
North Shore		
Thatcher Island, Rockport	1	0
Kettle Island, Gloucester	35	117
Eagle Island, Salem	3	4
Boston Harbor		
Calf Island, Boston	2 ^a	0 ^a
Outer Brewster Island, Boston	2 ^a	18 ^a
Middle Brewster Island, Boston	3	0
Sheep Island, Weymouth	0	4
Cape Cod		
South Monomoy Island, Chatham	1	0
Buzzards Bay		
Penikese Island, Gosnold	0	1
Total pairs, all sites	47	144
Total pairs, comparable sites	43	126

^a Counts at these sites are not directly comparable between survey periods because different methods were used in each period.

Table 8. Summary of changes in abundance of 8 species of coastal colonial waterbirds in Massachusetts based on 1994-95 and 2006-08 surveys using comparable methods.

Species	<u>No. pairs</u>		
	1994-95	2006-08	± % change
Double-crested Cormorant	6,375	5,134	- 19.5
Herring Gull	15,812	9,143	- 42.2
Great Black-backed Gull	14,616	8,774	- 40.0
Laughing Gull	868	1,585	+ 82.6
Great Egret	69	228	+ 230.4
Snowy Egret	627	401	- 36.0
Black-crowned Night-Heron	1,428	781	- 45.3
Glossy Ibis	43	126	+ 193.0

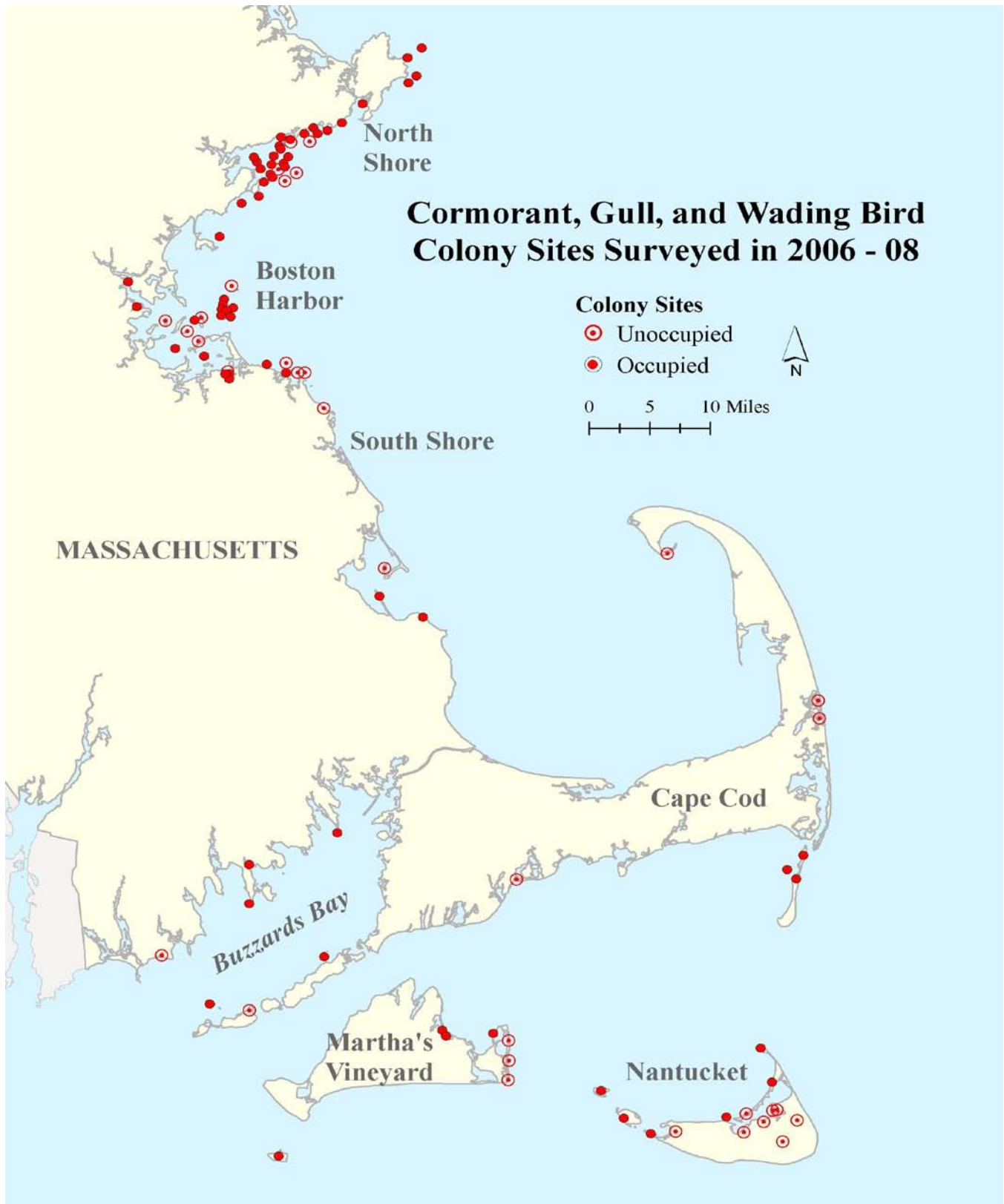


Figure 1. Locations of colony sites surveyed for nesting cormorants, gulls, and wading birds In Massachusetts, 2006-08.

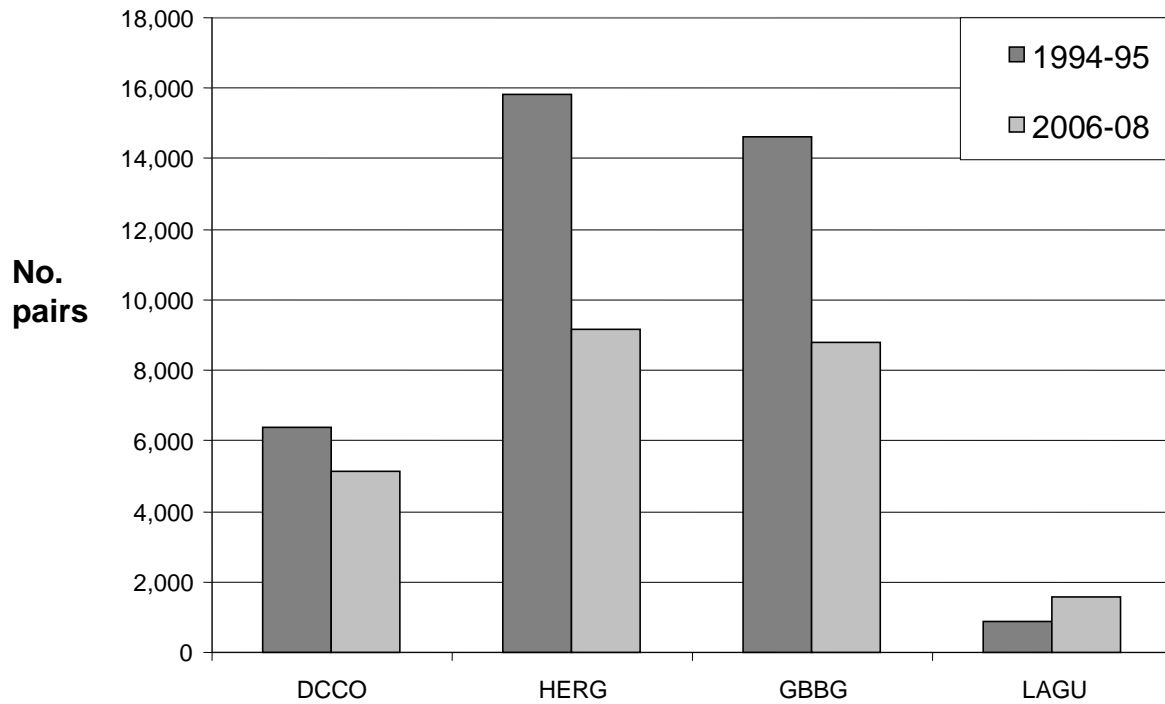


Figure 2. Abundance of breeding cormorants and gulls in Massachusetts, based on comparable surveys, 1994-95 and 2006-08.

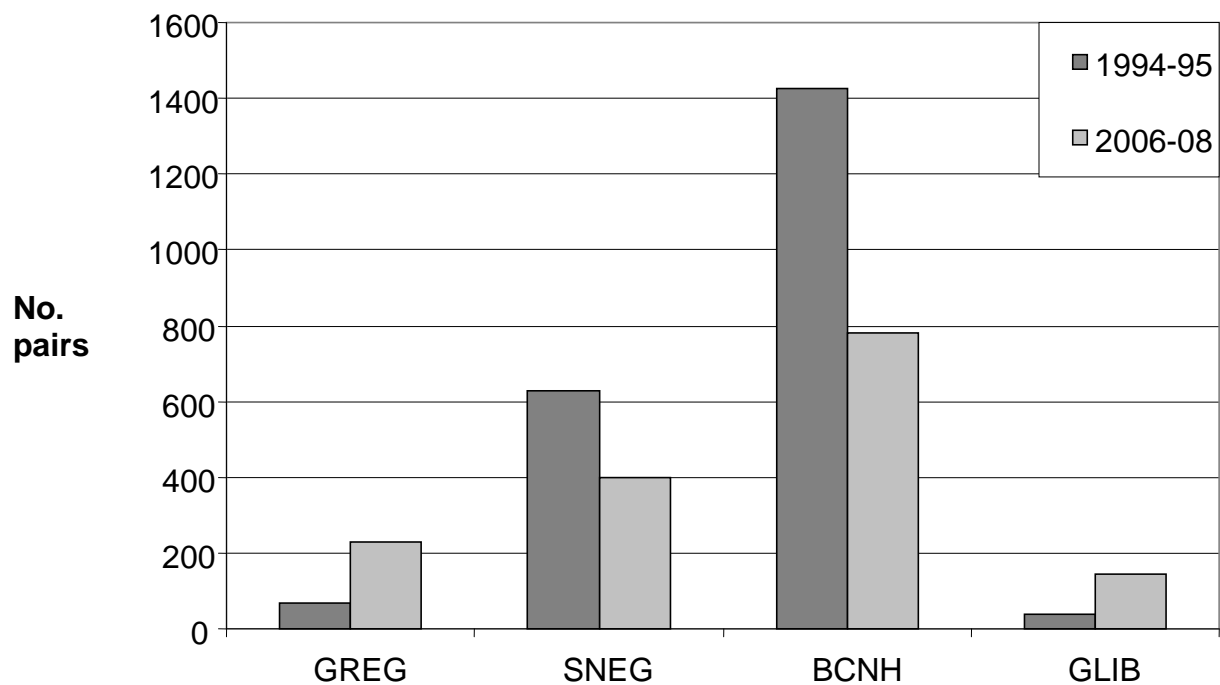


Figure 3. Abundance of breeding egrets, night-herons, and ibises in Massachusetts based on comparable surveys, 1994-95 and 2006-08.

Appendix 1. Results of the 2006-08 survey of 10 species of colonial-nesting coastal waterbirds (Double-crested Cormorant, Great Egret, Snowy Egret, Little Blue Heron, Cattle Egret, Black-crowned Night-Heron, Glossy Ibis, Laughing Gull, Herring Gull, Great Black-backed Gull) in Massachusetts and comparison with the 1994-1995 survey.

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
NORTH SHORE				
Chaces Is., Newbury	HERG	1	nd ^f	NCG
Dry Salvages, Rockport	DCCO	19 ^b	4	NCG/NCB
Straitsmouth Is., Rockport	HERG	23	0	NCG
	GBBG	143	22	NCG
Thatcher Is., Rockport	DCCO	0	3	NCG
	BCNH	1	0	NCG
	GLIB	1	0	AEG
	HERG	1,359	855	NCG
	GBBG	549	344	NCG
Milk Is., Rockport	DCCO	1,081	592	NCG
	HERG	533	340	NCG
	GBBG	1,070	591	NCG
Tenpound Is., Gloucester	BCNH	0	9	NCG
	HERG	75	13	NCG
	GBBG	70	40	NCG
Norman's Woe, Gloucester	DCCO	199	161	NCG
	HERG	76	73	NCG
	GBBG	4	12	NCG
Kettle Is., Gloucester	GREG	42	102	NCG
	SNEG	207	231	NCG
	LBHE	6	17 ^{g, h}	NCG/ACG
	BCNH	7	35	NCG
	GLIB	35	117	NCG
	HERG	388	226	NCG
	GBBG	146	121	NCG
Graves Is., Manchester	DCCO	0	42	NCG
	HERG	97	76	NCG
	GBBG	74	48	NCG

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
Great Egg Rock, Manchester	DCCO	124	40	NCB
	HERG	0	9	NCB
	GBBG	2	6	NCB
Salt Rock, Manchester	DCCO	nd	0	NCB
	HERG	nd	0	NCB
	GBBG	nd	0	NCB
Rock Dundy, Manchester	DCCO	0	12	ACB/NCB
	HERG	23	2	ACB/NCB
	GBBG	3	0	ACB/NCB
Ram Is., Manchester	DCCO	0	0	NCB
	HERG	0	0	NCB
	GBBG	2	3	NCB
House Is., Manchester	DCCO	0	0	NCG
	HERG	0	0	NCG
	GBBG	0	0	NCG
Chubb Is., Beverly	DCCO	0	6	NCG
	HERG	10	28	NCG
	GBBG	59	33	NCG
Great Misery Is., Salem	DCCO	0	0	NCG/NCB
	HERG	0	1	NCG/NCB
	GBBG	0	1	NCG/NCB
Little Misery Is., Salem	DCCO	0	0	ACB/NCB
	HERG	0	1	ACB/NCB
	GBBG	0	0	ACB/NCB
Bakers Is., Salem	DCCO	0 ^b	0	NCG/NCB
	HERG	0 ^b	75	NCG/NCB
	GBBG	0 ^b	7	NCG/NCB
Coney Is., Salem	DCCO	66	64	NCG
	BCNH	2	0	NCG
	HERG	158	94	NCG
	GBBG	25	51	NCG

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
Pope Head, Salem	DCCO	0	0	NCB
	HERG	4	0	NCB
	GBBG	1	0	NCB
Great Haste Is., Salem	DCCO	7	0	NCB
	HERG	57	11	NCB
	GBBG	1	0	NCB
Eagle Is., Salem	DCCO	0	13	NCG
	GREG	0	16	NCG
	SNeg	16	10 ^g	NCG/ACG
	CAEG	2	2 ^g	NCG/ACG
	BCNH	86	53	NCG
	GLIB	3	4	NCG
	HERG	166	90	NCG
	GBBG	54	30	NCG
North Gooseberry Is., Salem	DCCO	70	94	NCG
	HERG	43	22	NCG
	GBBG	71	36	NCG
South Gooseberry Is., Salem	DCCO	92	50	NCB/NCG
	HERG	40	17	NCB/NCG
	GBBG	31	33	NCB/NCG
Dry Breakers, Salem	DCCO	nd	0	NCB
	HERG	nd	0	NCB
	GBBG	nd	0	NCB
Cat Is., Salem	DCCO	34	0	NCG
	HERG	136	260	NCG
	GBBG	281	146	NCG
Is. south of Cat Is. (Cormorant Rock), Salem	DCCO	234	139	NCB
	HERG	7	14	NCB
	GBBG	5	4	NCB

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
Tinkers Is., Salem	DCCO	0	0	NCG
	HERG	116	189	NCG
	GBBG	0	10	NCG
Halfway Rock, Salem	DCCO	nd	0	NCB
	HERG	nd	0	NCB
	GBBG	nd	0	NCB
Marblehead Rock	DCCO	14	21	NCB
	HERG	79	17	NCB
	GBBG	30	3	NCB
Grays Rock, Marblehead	DCCO	152	15	NCB
	HERG	0	2	NCB
	GBBG	0	0	NCB
Ram Is., Marblehead	DCCO	0 ^b	190	NCG
	HERG	152 ^b	256	NCG
	GBBG	80 ^b	84	NCG
Egg Rock, Nahant	DCCO	436	138	NEB/NCB
	HERG	107	68	ACB/NCB
	GBBG	44	11	ACB/NCB
BOSTON HARBOR				
Mystic River MBTA sites, Everett, Charlestown, Medford (Wellington) ⁱ	HERG	239 ⁱ	22 ⁱ	NCG ⁱ
	GBBG	11 ⁱ	0 ⁱ	NCG ⁱ
Green Is., Boston	DCCO	393	90	NCG/NCB
	HERG	206	30	NCG/NCB
	GBBG	111	20	NCG/NCB
Little Calf Is., Boston	DCCO	189	147	ACB/NCB
	HERG	0	0	ACB/NCB
	GBBG	8	0	ACB/NCB

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
Calf Is., Boston	DCCO	0	0	NCG
	BCNH	1	28	AEG/NCG
	GLIB	2	0	AEG/NCG
	HERG	352	197	NCG
	GBBG	152	63	NCG
The Graves, Boston	DCCO	nd	0	NCB
	HERG	nd	0	NCB
	GBBG	nd	0	NCB
Outer Brewster Is., Boston	DCCO	90	60	AEG/NCG
	SNEG	5	14	AEG/NCG
	LBHE	0	1	AEG/NCG
	BCNH	25	38	AEG/NCG
	GLIB	2	18	AEG/NCG
	HERG	329	215	NCG
	GBBG	333	55	NCG
Middle Brewster Is., Boston	DCCO	878	772	NCG
	GREG	8	0	NCG
	SNEG	75	0	NCG
	BCNH	207	23	NCG
	GLIB	3	0	NCG
	HERG	700	364	NCG
	GBBG	114	96	NCG
Great Brewster Island, Boston	HERG	398	156 ^c	NCG
	GBBG	12	16 ^c	NCG
Shag Rocks, Boston	DCCO	290	96	AEB/NCB
Lovell Is., Boston	DCCO	0	0	NCG
	HERG	0	0	NCG
	GBBG	0	0	NCG
Gallops Is., Boston	DCCO	0	0	NCG
	BCNH	38	0	NCG
	HERG	118	82	NCG
	GBBG	8	29	NCG
Spectacle Is., Boston	- ^j	0	0 ^c	ACB

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
Rainsford Is., Boston	_ ^j	0	0 ^c	ACG
Boston Fish Pier rooftops, South Boston ^k	HERG	9 ^b	9 ^{c,k}	NCG
	GBBG	1 ^b	0 ^{c,k}	NCG
Dorchester gas tanks, Boston	HERG	131 ^b	nd	NCG
	GBBG	9 ^b	nd	NCG
Hangman Is., Quincy	DCCO	0	0	NCG/NCB
	HERG	4	7	NCG/NCB
	GBBG	61	42	NCG/NCB
Squantum warehouse, Quincy	HERG	105 ^b	nd	NCG
	GBBG	22 ^b	nd	NCG
Peddocks Is., Hull	BCNH	2	0 ^c	NCG/ACG
Sheep Is., Weymouth	DCCO	0	15	NCG
	SNEG	0	6	NCG
	BCNH	14	4	NCG
	GLIB	0	4	NCG
	HERG	273	243	NCG
	GBBG	6	23	NCG
Sarah Is., Hingham	DCCO	17	155	NCG
	GREG	1	76	NCG
	SNEG	148	49	NCG
	BCNH	547	343	NCG
	HERG	224	215	NCG
	GBBG	31	40	NCG
Ragged Is., Hingham	DCCO	0	0	NCG
	HERG	4	1	NCG
	GBBG	2	0	NCG
Langlee Is., Hingham	HERG	2	0	NCG
	GBBG	0	0	NCG

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
Button Is., Hingham	DCCO	0	0	NCG
	HERG	1	8	NCG
	GBBG	0	0	NCG
SOUTH SHORE				
Black Rocks, Hull	DCCO	39 ^b	68	NCG/NCB
	HERG	273 ^b	28	NCG/NCB
	GBBG	36 ^b	5	NCG/NCB
Brush Is., Cohasset	DCCO	747	384	NCG/NCB
	HERG	136	72	NCG/NCB
	GBBG	51	60	NCG/NCB
Sutton Rock, Cohasset	_ j	nd	0	ACB
West Shag Rock, Scituate	_ j	nd	0	ACB
East Shag Rock, Scituate	_ j	nd	0	ACB
Gull Is., Scituate	DCCO	0 ^b	0	NCG/ACB
	HERG	44 ^b	0	NCG/ACB
	GBBG	2 ^b	0	NCG/ACB
Clarks Is., Plymouth	DCCO	21	0 ¹	NCG/ACB
	HERG	411	0 ¹	NCG/ACB
	GBBG	209	0 ¹	NCG/ACB
Plymouth Long Beach, Plymouth	LAGU	10	59 ^{c,m}	NCG
	HERG	150	1 ^{c,m}	NCG
	GBBG	10	0 ^{c,m}	NCG
	GBBG	2	0 ^{c,m}	NCG/ACB
Pilgrim Nuclear Power Station., Plymouth	HERG	22 ^b	20 ^{c,n}	NCG
	GBBG	3 ^b	0 ^{c,n}	NCG

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
CAPE COD				
Dead Neck-Sampsons Is., Barnstable	GREG	7	0	NCG
	SNEG	38	0	NCG
	BCNH	73	0	NCG
	HERG	769	0	NCG
	GBBG	147	0	NCG
North Monomoy Is., Chatham	SNEG	0 ^b	2	NCG
	BCNH	0 ^b	6	NCG
	LAGU	0 ^b	0	NCG
	HERG	1,252 ^b	1,354 ^{c,o}	NCG
	GBBG	415 ^b	741 ^{c,o}	NCG
“Minimoy Is., Chatham ^o	LAGU	0	14 ^c	NCG
	HERG	0	0 ^c	NCG
	GBBG	0	0 ^c	NCG
South Monomoy Is., Chatham	GREG	0	1	NCG
	SNEG	69	5	NCG
	BCNH	201	152	NCG
	GLIB	1	0	NCG
	LAGU	0 ^b	1,498 ^c	NCG
	HERG	3,963 ^b	1,372 ^{c,q}	NCG/NCG ^q
	GBBG	6,946 ^b	3,152 ^{c,q}	NCG/NCG ^q
New Island, Orleans/Eastham	LAGU	832	0 ^c	NCG
Nauset Spit / “Plover Island”, Eastham	LAGU	26	0 ^c	NCG
Long Point / Wood End, Provincetown	BCNH	7	0 ^c	NCG
	HERG	464	0	NCG
	GBBG	82	0	NCG
Provincetown Breakwater, Provincetown	DCCO	15	nd	NCG

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
ELIZABETH ISLANDS				
Weepeeket Islands, Gosnold	DCCO	1,878	1,498	NCG
	HERG	245	209 ^r	NCG ^r
	GBBG	273	217 ^r	NCG ^r
Cedar Is., Lackey's Bay, Naushon Is.	HERG	1	nd	NCG
Nashawena Island, Gosnold	HERG	0	0 ^s	NCG
	GBBG	6	0 ^s	NCG
Penikese Is., Gosnold	GREG	0	7	NCG
	SNEG	0	37	NCG
	BCNH	18	19	NCG
	GLIB	0	1	NCG
	HERG	759	1,049	NCG
	GBBG	42	86	NCG
BUZZARDS BAY				
Bird Is., Marion	HERG	4	0	NCG
	GBBG	5	5	NCG
Pea Islands, Fairhaven	HERG	nd	2 ^t	NCB ^t
	GBBG	nd	0 ^t	NCB ^t
Angelica Rock, Fairhaven	DCCO	130	186	NCG
	HERG	218	99 ^u	NCG
	GBBG	54	18 ^u	NCG
ComGas Electric Plant, New Bedford	HERG	92 ^b	nd	NCG
	GBBG	0 ^b	nd	NCG
New Bedford State Pier (roof)	HERG	45 ^b	nd	NCG
	GBBG	1 ^b	nd	NCG

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
Barneys Joy/Allens Pond, Dartmouth	HERG	0 ^b	0 ^c	NCG
	GBBG	1 ^b	0 ^c	NCG
MARTHA'S VINEYARD				
Cape Pogue Elbow, Chappaquiddick Is., Edgartown	SNEG	25	0 ^c	AEG/ACG
	BCNH	60	0 ^c	NCG
	HERG	3	0 ^c	NCG
	GBBG	173	171 ^c	NCG
Little Neck, Chappaquiddick Is., Edgartown	— ^j	0	0 ^c	ACG
East Beach, Chappaquiddick Is., Edgartown	— ^j	0	0 ^c	ACG
Wasque, Chappaquiddick Is., Edgartown	— ^j	0	0 ^c	ACG
Big Gravel Is., Sengekontacket Pd., Oak Bluffs	DCCO	nd	0 ^c	NCG
	HERG	nd	1 ^c	NCG
	GBBG	nd	4 ^c	NCG
Sarson Is., Sengekontacket Pd., Oak Bluffs	DCCO	230	254 ^c	NCG
	HERG	90	28 ^c	NCG
	GBBG	30	58 ^c	NCG
Haystack Pt., Sengekontacket Pd., Edgartown	DCCO	0	nd	NCG
	HERG	0	nd	NCG
	GBBG	1	nd	NCG

REGION, COLONY NAME, TOWN	SPECIES CODE ^a	NO. OF PAIRS		SURVEY METHOD ^{d, e}
		1994-95 ^b	2006-08 ^c	
Nomans Land, Chilmark	DCCO	392 ^b	630	NCG
	SNEG	13 ^b	0	ACG
	BCNH	75 ^b	<i>present</i> ^v	AEG
	HERG	886 ^b	375 ^v	NEG
	GBBG	287 ^b	125 ^v	NEG
NANTUCKET				
Great Point, Nantucket	HERG	24	147 ^w	NCG
	GBBG	9	119 ^w	NCG
Coskata-Coatue, Nantucket	GREG	11	26	NCG
	SNEG	31	47	NCG
	BCNH	99	60	NCG
	HERG	278	374 ^x	NCG
	GBBG	812	654 ^x	NCG
Smith Point (Esther Is.), Nantucket	HERG	0	3	NCG
	GBBG	0	101	NCG
Harbor Jetties, Nantucket	DCCO	nd	24	NCB
Miscellaneous sites, Nantucket ^y	- ^j	nd	0 ^y	NCG
Tuckernuck Is., Nantucket	BCNH	40 ^b	8	NCG
	HERG	579 ^b	180 ^z	NCG/NMR ^z
	GBBG	451 ^b	370 ^z	NCG/NMR ^z
Muskeget Is., Nantucket	BCNH	0 ^b	3	AEG/NCG
	HERG	212 ^b	122 ^z	NCG/NMR ^z
	GBBG	1,494 ^b	1,140 ^z	NCG/NMR ^z

^a Species codes: DCCO = Double-crested Cormorant, GREG = Great Egret, SNEG = Snowy Egret, LBHE = Little Blue Heron, CAEG = Cattle Egret, BCNH = Black-crowned Night-Heron, GLIB = Glossy Ibis, LAGU = Laughing Gull, HERG = Herring Gull, GBBG = Great Black-backed Gull

^b Most colony sites were surveyed in only one year during the 1994-95 survey. When a site was surveyed in both those years, the larger of the 2 counts is reported here. Sites surveyed in 1995 only are foot-noted “b”.

^c Colony sites were surveyed in only one year during 2006-07. Most sites were surveyed in 2006; sites that are foot-noted “c” were surveyed in 2007. Clarks Island, Duxbury, was surveyed in 2008.

^d Survey methods: NCG = nest count ground, NCB = nest count boat, NEB = nest estimate boat, ACG = adult count ground, ACB = adult count boat, AEB = adult estimate boat, AEG = adult estimate ground, M/R = nest count ground using mark/recapture (Lincoln-Peterson method) (Brower and Zar 1977).

^e Where a single method is listed for a site, that method was used in both the 1994-95 and 2006-08 surveys. Where 2 methods are listed, the first was used in 1994-95, the second in 2006-08.

^f nd = no data were reported

^g Counts in 2006 of pairs of Little Blue Herons (LBHE) at Kettle Island, Gloucester, and Snowy Egrets and Cattle Egrets at Eagle Island, Salem, were obtained by watching unobtrusively from vantage points outside the colonies for ≥ 30 minutes until adults had settled back onto or adjacent to their nests. A “pair” was defined as either an adult, or 2 adults near each other, obviously occupying a nest or small “patch” of nesting habitat.

^h At Kettle Island, Gloucester, the count of 17 breeding pairs of Little Blue Herons on 18 May 2006 was considered a minimum estimate (fide S. Perkins).

ⁱ Mystic River MBTA sites are rooftops of 4 garages and maintenance facilities in Everett, Charlestown, and Medford (Wellington). Data in 1995 were nest counts, and in 2006 were numbers of nests reported destroyed pursuant to a depredation permit issued by U.S. Fish and Wildlife Service.

^j No target species were detected during surveys.

^k Counts of gulls on Boston Fish Pier rooftops in 2007 were the numbers of nests reported destroyed in May pursuant to a depredation permit issued by U.S. Fish and Wildlife Service. Although data are also available on gull nests destroyed on roofs of MassPort facilities in South Boston in 2007, these are not directly comparable with data collected in 1995 because the sets of rooftops surveyed in 1995 and 2007 only partially matched, and because the 2007 data on nests destroyed did not distinguish between Herring Gull and Great Black-backed Gull nests.

^l Clarks Island, Plymouth, was slowly circumnavigated by small boat twice on June 5, 2008. No cormorants or wading birds were observed, nor did we see any evidence of nesting by gulls, cormorants, or wading birds along the shoreline or on the coastal banks of the island or in trees or shrubs along the top of the banks. Efforts by a local landowner to discourage nesting are believed to have led to the break-up of waterbird colonies on Clarks Island sometime after the 1994-95 surveys.

^m Counts of gull nests reported for Plymouth Long Beach were made in 2007. In 2006, no nests of Laughing Gull, Herring Gull, or Great Black-backed Gull were observed there.

ⁿ For Pilgrim Nuclear Power Station, Plymouth, data are counts of gull nests destroyed in 2007 pursuant to a depredation permit issued by U.S. Fish and Wildlife Service.

^o Observers counted 1,245 Herring Gull (HERG) nests and 683 Great Black-backed Gull (GBBG) nests on North Monomoy Island on 26 May 2007. An additional 167 nests that could not be confidently identified to species in the field were subsequently classified as either HERG (109) or GBBG (58) based on the observed ratio of the HERG and GBBG nests that were identified in the field.

^p “Minimoy Island” is a small, sandy island west of North and South Monomoy islands, Chatham, that has accreted over the past decade. It was not substantial enough in 1994-95 to support nesting gulls. The count of 14 pairs of Laughing Gulls is from 2007.

^q At South Monomoy Island, Chatham, total pairs of Herring Gulls and Great Black-backed Gulls were extrapolated from transect counts of gull nests conducted on 29 and 30 May 2007. Transects were systematically distributed across the island and were estimated to cover > 11% of available nesting habitat.

^r Gull nests on South Weepecket Island (the largest of the Weepecket Islands) were assigned to species based on adult count proportions of 0.5 (HERG) and 0.5 (GBBG) applied to a total of 208 undifferentiated gull nests.

^s At Nashawena Island, ground surveys in 2006 and 2007 determined that there were no nesting gulls on the barrier beach and dunes east of Quicks Hole Pond where they were reported in 1977 (Erwin and Korschgen 1979). Other sites at North Point and The Neck that formerly supported nesting colonies of gulls, Snowy Egrets, or Black-crowned Night-Herons in 1977 or 1984 (Erwin and Korschgen 1979, Andrews 1990) were not visited on the ground in 2006 or 2007, but when viewed by boat there was no evidence to suggest nesting by these species at these former sites or elsewhere along the eastern or northern shores of Nashawena. Eastern Coyotes became established on Nashawena during the 1980s and may have eliminated nesting gulls, egrets, and Night-Herons from these former colony sites. No nesting gulls were observed at Barets Rock or Canapitsit in 2006.

^t At the Pea Islands, Fairhaven, 1 HERG nest was counted by boat on 30 May 2006 on the higher island, and a second HERG nest with hatching eggs was tallied during a ground count of the lower island on 20 June 2006.

^u Gull nests on Angelica Rock in 2006 were assigned to species based on adult count proportions of 0.85 (HERG) and 0.15 (GBBG) applied to a total of 117 undifferentiated gull nests.

^v At Nomans Land, Chilmark, complete censuses of target species other than Double-crested Cormorant were not done in 2006-08 because of inclement weather, constraints in time and numbers of observers, and safety concerns regarding unexploded ordinance (S. Koch, U.S. Fish and Wildlife Service, pers. com.). Casual observations during those years estimated 500 (\pm 200) nesting pairs of gulls on the island, with \leq 75% of those estimated to be Herring Gulls and the rest Great Black-backed Gulls. Observers were of the opinion that numbers of nesting gulls had declined on the island over the previous 10 years. In 2008, an incomplete survey of Black-crowned Night-Herons found 3 nests. Although comprehensive searches for nests of Snowy Egrets were not carried out in 2006-08, no Snowy Egrets were observed anywhere on the island during visits in May, June, and July 2006-08.

^w At Great Point, Nantucket on 22 May 2006, 103 nests of Herring Gull (HERG) and 83 nests of Great Black-backed Gull (GBBG) were counted, plus 80 nests that could not be confidently identified to species in the field that were subsequently classified as either HERG (44) or GBBG (36) based on the observed ratio of HERG and GBBG nests.

^x At Coskata-Coatue, Nantucket in 2006, 3 subcolonies of nesting gulls were identified and surveyed: Coatue NE, Coatue SW, and Coatue-Middle. Nest totals for all of Coaskata-Coatue included 289 nests identified as HERG and 502 as GBBG, plus 237 nests that could not be confidently identified to species in the field that were subsequently classified as either HERG (85) or GBBG (152) based on the observed ratio of HERG and GBBG nests..

^y The following 8 historic or potential heron/egret colony sites on Nantucket were field-checked in May 2006, but no nesting colonial waterbirds were present: Coatue-Second Point; University of Massachusetts Nantucket Field Station; Stump Pond (south of Windswept Cranberry Bog); Gibbs Pond (northwest of Milestone Cranberry Bog); Quaise; Monomoy; Medouie Creek (near the mouth of Polpis Harbor; and Warren's Landing (Madaket) (Beattie 2006).

^z At Tuckernuck and Muskeget islands in 2006, counts of gull nests were derived from simple mark-recapture (Lincoln-Peterson method) procedures.