2-2013

Report to the City of Chicago on Conflicts with Ring-billed Gulls and the 2012 Integrated Ring-billed Gull Damage Management Project

J. W. Hartmann
USDA-APHIS-Wildlife Services

S. F. Beckerman
USDA-APHIS-Wildlife Services, Sc.Beckerman@aphis.usda.gov

Richard M. Engeman
USDA-APHIS-Wildlife Services, s_r100@yahoo.com

T. W. Seamans
USDA/APHIS/WS National Wildlife Research Center, thomas.w.seamans@aphis.usda.gov

Report to the City of Chicago on Conflicts with Ring-billed Gulls and the 2012 Integrated Ring-billed Gull Damage Management Project

Prepared for
Chicago Park District

By

J.W. Hartmann[1], S.F. Beckerman[1], R. M. Engeman[2], and T.W. Seamans[3]

February 8, 2013

[1] USDA-APHIS-Wildlife Services, 3430 Constitution, Suite 121, Springfield, Illinois 62711
[2] USDA-APHIS-WS-National Wildlife Research Center, 4101 LaPorte Ave., Fort Collins, CO 80521
[3] USDA-APHIS-WS-National Wildlife Research Center, 6100 Columbus Ave., Sandusky, OH 44870

EXECUTIVE SUMMARY

The large ring-billed gull (*Larus delawarensis*) population in the City of Chicago has caused various conflicts including general nuisance, property damage, economic losses, and threats to human health and safety. Several studies have shown a relationship between ring-billed gulls and increased levels of fecal indicator bacteria (FIB) such as *Escherichia coli (E. coli)* in nearshore waters. Results of tests for *E. coli* have led to the issuance of swim advisories at Chicago beaches.

The objectives of the Chicago Ring-billed Gull Damage Management Project were to (1) reduce the local production of ring-billed gulls, (2) reduce the severity of conflicts with gulls including the issuance of swim advisories, and (3) evaluate how limiting the production of gulls affects gull use of Chicago's beaches. We hypothesized that oiling the majority of ring-billed gull eggs will continue to reduce the number of hatch-year ring-billed gulls produced in Chicago, and that the decrease in the number of hatch-year ring-billed gulls will therefore reduce severity of conflicts with gulls, including swim advisories on Chicago's beaches.

Since the beginning of the Chicago Ring-billed Gull Damage Management Project in 2007, USDA-WS established that oiling eggs with food-grade corn oil was a successful method in reducing gull production. Between 2007 and 2012, 84,745 ring-billed gull nests were rendered inviable. It is estimated that since the initiation of this project, between 67,796 and 161,015 hatch-year ring-billed gulls have been prevented

Management of ring-billed gull nests has contributed to a significant reduction in hatch-year gull use of Chicago beaches. Since 2007, hatch-year gull use of beaches has declined by 94%, with 8 of 9 analyzed beaches observing a significant reduction. The combined observations of hatch-year and after hatch-year gull use of beaches illustrated a reduction in gulls compared to 2007 observation totals. Reduction in conflicts with landowners and land managers has been documented as a result of efforts to limit production of young.

The connection between ring-billed gulls and water quality is becoming more evident. It has been demonstrated that a relationship exists between gulls and the concentration of *E. coli* at beaches. During our six treatment years and the prior (pretreatment) year, the Chicago Park District has routinely sampled for *E. coli* as a FIB to assess water quality. During the 2012 swim season the proportion of tests resulting in a swim advisory compared to 2006 (baseline year) declined at 12 of 14 beaches.

BACKGROUND

The ring-billed gull is a medium-sized gull with adult plumage consisting of a white head, neck, underside, and tail contrasting with its grey wings. Adults measure 45 cm from bill to tail, having a 50 cm wingspan and weighing about 0.7 kg (Godfrey 1966). Wing-tips of primaries are black with white spots and the legs and feet are yellow-green. The bird's name originates from a distinctive black ring around the tip of the bill. The ring-billed gull is an adaptable and opportunistic bird often found nesting in colonies on break walls, bare soil, piers, structures, and rocks (Schreiber and Schreiber 1975).

Ring-billed gulls are gregarious nesters requiring only a small territory, and their colonies often contain thousands of pairs. Herring gulls (*Larus argentatus)*, Canada geese *(Branta Canadensis*), common terns (*Sterna hirundo*), and Caspian terns *(Hydroprogne caspia)* are often seen sharing colonies with ring-billed gulls in the Great Lakes Region. Ring-billed gulls are faithful to their nesting regions. Gabrey (1996) reported that 41% of sub-adults and 63% of adults return to their natal colonies. Banding data revealed little immigration or emigration in or out of the Great Lakes Region deeming it a closed system (Weseloh 1984, Gabrey 1996). Over 75% of breeding adults and 55% of chicks banded at a colony were recovered <39 km from the colony in subsequent breeding years (Gabrey 1996).

Ring-billed gulls are long lived birds with few factors contributing to mortality. USGS records indicate the oldest band record for a ring-billed gull is 27 years, 6 months (J. Lutmerding, USGS, Bird Banding Laboratory, personal communication, October 11, 2012). While the average ring-billed gulls lifespan is 10 to 15 years (Ryder 1993). Gulls generally nest in isolated areas over water and therefore have few natural predators. Ring-billed gulls were drastically reduced by hunting in the late nineteenth century due to an increased demand for white feathers in the fashion industry (Graham 1975). However, the Migratory Bird Treaty between Canada

and the United States in 1916 afforded protection which fostered an increase in population (Canadian Wildlife Service 1975).

Gull foraging behavior

Gulls are adaptable, opportunistic feeders that readily switch food types based on availability and accessibility (Veermer 1970). The diet of ring-billed gulls is highly variable (Darling 1965). Gulls feed on dead fish and garbage, are known to seek out earthworms following rain events, feed on insects and rodents when available in high numbers, and are often seen accepting food from members of the public. Gulls spend their nights at a common roost, usually on a lake, a river, or a structure where they are safe from mammalian predators and from human disturbance (Costello 1971). Prior to sunset and again at sunrise they can be seen commuting between their daytime feeding and loafing sites and their night-time roosts. Adult ring-billed gulls at Great Lakes nesting colonies have been known to travel an average of 25 km to utilize anthropogenic food sources (Belant et al. 1998).

Gull breeding biology

Ring-billed gulls attain sexual maturity in 2 to 3 years (Ludwig 1974). Gulls begin to arrive on the breeding colonies in the Great Lakes Region in late February to early March. Upon arrival, gulls spend nearly a month establishing territories, engaging in courtship rituals, and building nests. Egg laying begins in April in the Great Lakes Region with an average clutch consisting of 2.82 +/- 0.45 eggs (Mousseau 1984). Eggs are green to brown with dark spots. Adult pairs take turns incubating the eggs for approximately 25 to 27 days. The average hatching success ranges from 75% to 94% with an average fledge rate ranging from of 0.80 to 1.9 young per nest (Mousseau 1984, Brown and Morris 1994, Brown and Morris 1996).

Gull populations

Data on ring-billed gull populations in Illinois are limited. Information on gull populations in Illinois is provided for informational purposes. Data from the USGS Breeding Bird Survey (Sauer et al. 2011) for the period of 1966-2010 indicated that the ring-billed gull populations have increased in Illinois (Figure 1).

The Colonial Waterbird Survey was conducted in 1999 and covered the shoreline and islands of the Great Lakes and some inland colonies near the shore of the Great Lakes. Survey data indicated that there were 7,381 nesting pairs of ring-billed gulls on the Illinois portion of the Lake Michigan coast, an additional 31,161 pairs of ring-billed gulls along the Indiana portion of the Lake Michigan coast, and 29,166 pairs of ring-billed gulls at 21 sites along the southern half of the Wisconsin portion of the Lake Michigan coast (Cuthbert et al. 2003). This survey was not a complete count of gulls nesting in the states and did not include any birds that might have been nesting on inland lakes and rivers, nor was it a complete census of rooftops and other nesting sites.

Conflicts with ring-billed gulls

The large population of gulls in the Chicago region causes a range of problems for people and the environment. These problems include causing a nuisance in public open spaces; contributing to property damage and economic losses to structures (e.g., flat roofs and stonework); adverse aesthetic impacts; foul odors near nesting sites; potential health and safety risks caused by accumulations of fecal material on buildings, near outdoor dining areas and at recreational sites; and potentially reducing recreational enjoyment of beaches by contributing bacteria that result in the issuance of swim advisories.

In Chicago, two major nesting colonies are near marinas and it is thought that adult gulls and their offspring from both colonies are partially responsible for excessive amounts of bird droppings on boats and docks in marinas. Gulls from the Dime Pier colony frequent Navy Pier, a popular tourist attraction, and create negative interactions with large numbers of people. Also, representatives from the Chicago Police Department-Marine and Helicopter Unit and the U.S. Army Corps of Engineers indicate that gulls create nuisances at their facilities (E. Beltran, Sgt of Police Chicago Police Marine Unit, personal communication, January 8, 2013 and G. Vejvoda, Facility Manager, U.S. Army Corps of Engineers, personal communication, April 26, 2012).

Research has documented that gulls are a source of fecal contamination at beaches. Fluctuations in gull populations at beaches have been correlated with changes in FIB densities in beach water samples (Converse et al. 2012, Whitman and Nevers 2003). Edge and Hill (2007) showed that bird droppings served as primary sources of *E. coli* contamination. Levesque et al. (2000) documented that the bacterial content of ring-billed gull droppings can contribute to microbiological contamination of recreational waters and Nugent et al. (2008) described how ring-billed and other gulls contributed to increased fecal coliform levels in a municipal drinking water source. Gull numbers at beaches appeared to be significantly correlated with water and foreshore sand concentrations of *E. coli* taken 24 hours later (Whitman et al. 2004). DNA fingerprinting of *Salmonella* isolates from sand and water at 63rd Street Beach were a reasonably good match to gull feces isolates, but other birds could also have been *Salmonella* vectors. Hansen et al. (2011) concluded that waterfowl, including Canada geese, ring-billed gulls, and Mallard ducks were the primary source of *E. coli* contamination at beaches, while also cautioning that total bird counts were not a reliable predictor of the main contributor of *E. coli*.

Further evidence was provided immediately to the north of Chicago, where the Lake County Illinois Health Department used DNA ribotyping to genetically analyze *E. coli* samples from four beaches and "found that gull feces were the predominant source of the bacterial counts" (Lake County Board 2004, Soucie and Pfister 2003, RTI International 2011). Further public health concerns were noted at beaches heavily used by gulls when additional studies conducted by the Lake County Illinois Health Department identified the pathogens *Salmonella* spp. and *Proteus mirabilis* in fresh gull feces at Lake County beaches (M. Adam, Lake County Health Dept., personal communication, July 29, 2009). It has also been demonstrated that in Racine, Wisconsin gull feces is capable of carrying human pathogens (Converse et al. 2012, Kinzelman et al. 2008) and that gulls are a significant non-point source of fecal contamination on beaches (Kinzelman et al. 2004).

The increased ring-billed gull population has also impacted aviation safety. Nationally, gulls are the species group most frequently involved in collisions with civil aircrafts in the USA. From 1990-2011, 8,881 gulls were reported struck nationally (Dolbeer et al. 2012). Additionally, gulls along with waterfowl and raptors are the species group responsible for the most damaging strikes (Dolbeer et al. 2012). Bird strikes into the windshield or engine of an airplane have the potential to cause substantial damage. For example, during takeoff from a Great Lakes airport an aircraft ingested gulls into two engines which subsequently caused an uncontained engine failure in one of the engines. Both engines were damaged beyond repair. Airport operations recovered 14 gull carcasses from the engine and runway, with estimated repair costs of $1 million for repairs and $0.5 million in lost revenue (Wright 2010). According to Federal Aviation Administration records, ring-billed gulls have been involved in collisions with aircrafts at Chicago Midway International Airport 74 times and Chicago O'Hare International Airport 102 times between January 1, 1990 and August 31, 2012 (FAA Birdstrike Database). Since it is estimated that only 20% to 25% of all bird strikes are reported (Conover et al. 1995, Dolbeer et al. 1995, Linnell et al. 1996, Linnell et al. 1999), the number of collisions with gulls in Chicago is likely much higher than FAA records indicate.

Lastly, evidence also suggests that other bird species may be negatively impacted by the increase in the ring-billed gull population. Researchers have implicated ring-billed gulls as negatively influencing nesting success of piping plovers and common terns (Maxson and Haws 2000, Morris et al. 1980).

Previous efforts addressing gull damage and conflicts at Chicago's beaches

The Chicago Park District (CPD) has employed an integrated approach to reducing the number of conflicts attributed to gulls at Chicago beaches. Most visibly, are the improvements in beach cleanliness. Public education and beach cleanup practices have contributed to a decline in the number of gulls foraging at Chicago beaches. Projects such as the Beach Ambassador Program have provided outreach to the public emphasizing the importance of not littering. An ample supply of trash receptacles (including solar powered compactors) in high traffic areas has led to less uncontained litter. Additionally, early morning cleanup crews and daily beach grooming efforts have been utilized to reduce the litter and therefore the number of gulls foraging on Chicago's beaches. Furthermore, the implementation of canine harassment has been valuable as a management technique at select locations. Beaches with historically high numbers of swim advisories and high gull use have benefitted from canine harassment (Hartmann et al, 2010). Canine harassment activities have

shown to be effective in significantly reducing the bird population while also providing reductions in FIB at the administered beach (Converse et al. 2012).

Managing nests to prevent reproduction

Oiling eggs with 100% food grade corn oil has been shown to be effective at reducing the hatch rate of gulls (Pochop et al. 1998, Blackwell et al. 2000). After multiple years of minimizing the production of fledglings through egg oiling, a reduction in the number of nesting attempts may be detectible at the gull colonies (Olijnyk and Brown 1999). It is also possible that gull nesting colonies may relocate as a result of the physical destruction of nests (Ickes et al. 1998), thus creating even more conflicts if relocated nesting colonies move closer to airports or on rooftops where significant damage could be sustained. However, egg oiling is a less intrusive method of preventing production than physical nest destruction and in USDA-WS experience is less likely to result in the relocation of a nesting colony (J. Cummings, USDA-WS, personal communication). In addition, egg oiling performed early in the nesting cycle is considered humane (Hadidian et al. 1997).

OBJECTIVES

The objectives of the Chicago Ring-billed Gull Damage Management Project were to (1) reduce the local production of ring-billed gulls, (2) reduce the severity of conflicts with gulls including the issuance of swim advisories, and (3) evaluate how limiting the production of gulls affects gull use of Chicago's beaches. We hypothesized that oiling the majority of ring-billed gull eggs will continue to reduce the number of hatch-year ring-billed gulls produced in Chicago, and that the decrease in the number of hatch-year ring-billed gulls will therefore reduce severity of conflicts with gulls, including swim advisories on Chicago's beaches.

METHODS

Colony assessment and egg oiling at Dime Pier, DuSable Harbor Breakwall, and Lake Calumet

Prior to initiating egg oiling, colony assessment visits to Dime Pier, DuSable Harbor Breakwall, and Lake Calumet took place on April 4, 2012. After the initial assessment, visits were conducted weekly to assess the colony size and nesting stage at those three sites. In order to facilitate the application of oil early in incubation, nesting chronology was estimated via egg flotation as described by Nol and Blokpoel (1983).

Once incubation began, eggs were treated with food grade corn oil that was applied using a pressurized four-gallon backpack tank and hand-held spray wand. The spray wand was equipped with a tip that produced a fan pattern. Sprayers were pressurized and delivered oil at rates between 3 to 6 ml/sec. The sprayer tips were held about 15 to 20 centimeters (6 to 8 inches) above each egg and approximately 3 ml of corn oil were applied to each egg. The oiling treatment consisted of two USDA-WS staff walking transects through the colony with backpack sprayers to apply corn oil to all eggs in each selected nest. All nests at Dime Pier were treated and counted. Nests at DuSable Harbor Breakwall were counted to determine a total colony count. The number of nests to be treated in order to reach 80% of the colony was calculated and then those nests were treated.

Ring-billed gull eggs were first identified on April 12 at Dime Pier and DuSable Harbor Breakwall. Oiling treatments first occurred on April 23. Three retreatments took place biweekly between May 9 and June 13. Due to the close proximity of Dime Pier and DuSable Harbor Breakwall, the nesting activity at these locations were considered to be one nesting colony and in the remainder of this report will be referred to as the Dime Pier colony.

During visits to Lake Calumet on April 4 and April 11, an estimated 1,000 ring-billed gulls were observed utilizing the dike, Gull Island, and adjacent waters. During our third and final visit Lake Calumet on April 25, we observed six nests on Gull Island and an estimated 30 gulls at the site. Throughout our visits to Lake Calumet we did not observe nests on the primary dike, which historically was used as the primary nesting location.

Data related to changes in total nest numbers and percentage of nests treated at each colony was compared between the six treatment years (2007 through 2012). The reported total number of nests that were treated at Dime Pier and Lake Calumet were based on the largest number of nests counted during a single round

of oiling. Nests that were not oiled were only counted once during the first treatment before chicks were present. Locations where nests were not oiled were marked with flagging tape. During the retreatment visits, areas that were flagged during the first treatment were avoided to minimize disturbance that might affect chick mortality (Fetterolf 1983).

Rooftop populations and new site identification

In the spring of 2011, an aerial survey was conducted to gain a better understanding of gull populations in Chicago. The survey resulted in locating three unknown rooftop nesting sites (Jardine Water Purification Plant, Midway1, and Midway2). In 2012, we revisited the three rooftop sites between April 11 and April 18 to identify nesting chronology and to facilitate early nest management. Nests at the Jardine Water Purification Plant were managed through egg oiling applications. Oiling treatments occurred on April 27, May 9, and May 23. Nest management at Midway1 and Midway2 involved nest and egg removal during visits on April 30, May 11, May 25, and June 6. In addition to oiling treatments at the Jardine Water Purification Plant, flagging tape and avian distress call boxes were installed by the property managers prior to the nesting season. Flagging tape was installed on sections of the rooftop that had the highest density of nests during 2011 while avian distress call boxes were installed in sections with low gull activity as a nesting deterrent.

Another aerial survey was completed on April 16, 2012 to aid in locating additional nesting sites. A crew of four people, which included the pilot and three observers, flew in and out of Chicago Executive Airport. The survey was conducted via helicopter at approximately 80 km/hr. at a minimum altitude of 152 m. Two transects approximately 1.6 km apart were completed parallel to Lake Michigan for the entire Cook County-Lake Michigan border. Additional survey locations included: Lake Calumet, North Branch of the Chicago River, Chicago Sanitary and Ship Canal, and Midway Airport.

Global Positioning System (GPS) coordinates were recorded for locations where groups of gulls were identified. Staff then conducted a visit to each identified site to determine if gulls observed during the aerial observations were nesting.

Gull observation surveys

To evaluate the efficacy of the program and accurately assess the number of gulls contributing to the deposition of fecal matter at beaches, observational surveys of gull presence were conducted at 19 locations along Chicago's shoreline (Figure 2). Observational surveys of gulls were conducted at beaches, harbors, and other historic gull use sites. Survey routes typically started from the northern-most or southern-most end of the city. Each survey location was traversed on foot and the number of hatch-year (HY) and after hatch-year (AHY) gulls observed on and within approximately 75 meters of the beach, (including nearby parks, parking lots, and shoreline) were counted and recorded. Additional data recorded during observational surveys included: time, weather conditions, and species of other shorebirds observed at each location. In addition to the surveys of gull use of Chicago beaches, the number of Canada geese present on beaches was also recorded at each site. Table 1 illustrates the number of surveys conducted each week in each of the six years when egg oiling was conducted.

On four separate occasions during the swim season, a secondary observer conducted an independent gull count simultaneously with the primary observer to assess accuracy of the primary gull observer's estimate of gull use of survey locations. The numbers of total gulls observed were compared after all observations were completed for the day to evaluate the similarity of the data. Observation estimates of the number of gulls using the locations were required to be within 10% of each other.

Complete data sets were available to analyze gull use for 9 of the 15 beaches surveyed. Analysis was conducted for weeks 5-10 of the observation periods. For each of the 9 beaches, the number of gulls observed during the surveys in each of the six one-week observation blocks across 2007, 2008, 2009, 2010, 2011, and 2012 were compared using a two-factor factorial analysis of variance. *A priori* linear contrasts were applied to the week-by-year interaction term to identify at what week of the six weeks analyzed (if any) the six years differed in the mean number of gulls observed. Separate analyses were conducted for HY, AHY, and total gulls, with the realization that analyses of the total gull numbers are descriptive ventures since total gull numbers are not independent from the two components, HY and AHY numbers. Data collected by the primary

and secondary observer were comparable, therefore, only the observations completed by the primary observer were analyzed.

Information was collected at 15 beaches during the entire 2012 swim season. Although statistical analyses were not possible or inappropriate for Foster, Montrose, Oakwood , 63rd Street, 57th Street, and South Shore Beaches, a descriptive evaluation between the mean number of HY, AHY, and total gulls is important to communicate.

Gull use totals at Foster, Montrose, 57th Street, and 63rd Street Beaches were altered due to gull harassment activities during our study period. On a trial basis, dispersal of gulls via canine harassment was conducted at Foster beach in 2006 and 2007 and at 63rd Street Beach in 2007. A full time harassment program was then implemented at 57th and 63rd Street Beaches during the entire 2008 swim season from dawn to dusk. In 2009, canine harassment did not take place at Chicago beaches. During 2010, 2011, and 2012 a full time canine harassment program was employed at 63rd Street Beach with intermittent visits taking place at 57th Street Beach.

Observations of 63rd Street Beach were conducted during canine harassment and pre-harassment periods for each week of our 2012 study period. We examined the differences in gull use at 63rd Beach including nearby breakwalls before and during harassment periods. Furthermore, in 2012 an intermittent harassment program took place for the first time at Montrose Beach. Observations at Montrose Beach included the Important Bird Area (IBA) and the adjacent public beach.

The IBA at Montrose is a designated habitat recognized by the National Audubon Society that protects breeding, wintering, and/or migrating birds. For that reason, canine harassment activities did not take place in the IBA and were limited to the public bathing portion of the beach. Differences in gull use at Montrose Beach and the IBA were examined during harassment and non-harassment periods. To minimize potential effects canine dispersal of gulls may have had on gull use of beaches and the associated observational data, Foster, Montrose, 57th Street, and 63rd Street Beaches were excluded from statistical analysis.

Observations occurred at Oakwood and South Shore Beaches during 2010, 2011, 2012. Surveys were not conducted during the first three years of the study period and therefore comparisons were limited to descriptive assessment for changes in gull use.

The Dime Pier nesting colony was observed periodically after oiling operations during the swim season. Fledge date, HY development, and gull movement patterns were observed and recorded for assessment.

Swim advisories on Chicago's beaches

The CPD regularly examines nearshore water quality at beaches in Chicago. In 2012, the CPD no longer issued swim bans based on water quality test results. Alternatively, CPD followed United States (U.S.) Environmental Protection Agency (EPA) recommended guidelines and issued swim advisories when E. coli results were above the federal threshold. Following U.S. EPA guidance, swim advisories were implemented in Chicago when the geometric mean of two *E. coli* sample readings exceeded the threshold of 235 most probable number (mpn) per 100 mL of sampled beach water. Although terminology for reporting swim bans and swim advisories have changed, the methodology used to collect water quality samples has remained unaffected throughout the period covered in this report. Thus, water quality data from 2006 was used as a pretreatment baseline and test results trends were examined across the six years of nest management.

The proportion of water quality tests exceeding 235 mpn/100 mL at 14 beaches were compared for the swim seasons between 2006-2012 (Table 2). This approach avoids conflict in inferences relative to the number of days during the week that a swim advisory was in place. Of most interest were comparisons for each beach between the pretreatment year (2006) and the final year of treatment in this study (2012). In addition to the 14 beaches, comparisons were made for the four beaches (Foster, Montrose, 57th Street, and 63rd Street) influenced by canine harassment activities during our study period. The extent of canine involvement is illustrated in Table 2.

RESULTS

Egg oiling and nesting chronology at Dime Pier and Lake Calumet

On April 12, USDA-WS observed nests with eggs for the first time at the Dime Pier colony. Four egg oiling treatments occurred between April 23 and June 13. Approximately 85% of the nests were treated at Dime Pier (4,055 nests containing 10,408 eggs) (Table 3, Figure 3). In 2012, the colony size at Dime Pier decreased by 344 nests (-7%) in comparison to 2011.

Approximately 1,000 gulls were witnessed utilizing the Lake Calumet colony on April 4 and April 11. Two weeks later, during a subsequent visit to the Lake Calumet region, gulls were no longer occupying the Lake Calumet dike. Upon further assessment, USDA-WS personnel identified six ring-billed gull nests on the nearby Gull Island. Nests on Gull Island were omitted from management activities during 2012. The Lake Calumet colony was initially abandoned during the 2010 nesting season, while partly returning in 2011. During both the 2010 and 2012 nesting season vegetation was visibly denser.

The total number of nests available to effectively manage in Chicago changed once again due to the abandonment of the Lake Calumet nesting site. Compared to 2011, there were 3792 (-44%) fewer total nests at the Dime Pier and Lake Calumet colonies (Table 3).

Gull chicks were first observed during the second retreatment on May 9 at Dime Pier. The first observation of a fledged HY gull occurred during a survey on June 25. The number of HY gulls observed on beaches continued to increase through observation periods 5-9. Based on increased HY gull beach use during observation block 6 and site visits to the Dime Pier colony, USDA-WS estimated a mean fledge date of July 7 for HY gulls from the managed colonies in Chicago.

Minimizing conflicts from rooftop nesting populations

On April 16, during the aerial survey, approximately 770 km^2 (298 mi^2) of Cook County were surveyed for gull colonies. During aerial observations one unknown nesting site was identified. Furthermore, locations of previously identified sites were surveyed to reconfirm gull use (Figure 2). This new nesting site was located within 4.5km (2.8mi) of five Chicago beaches (Juneway, Rodgers, Howard, Jarvis, and Leone/Loyola) in adjacent Lincolnwood, IL. During three visits to the Lincolnwood rooftop, 89 ring-billed gull nests and 191 herring gull nests were treated and removed.

Nests were once again managed at the three rooftop locations that were identified during the 2011 aerial survey (Midway1, Midway2, and Jardine Water Purification Plant). As was the case during 2011, USDA-WS determined that nesting should be discouraged at the sites and therefore 100% of the nests were treated or removed (Hartmann et al. 2012). Additionally, to discourage nesting at the Jardine Water Purification Plant, flagging tape and avian distress call boxes were installed prior to the nesting season. During the first visit to the site on April 12, gulls were observed loafing only on sections of the rooftop without the flagging tape. On subsequent visits, nests were located on rooftop sections with the call boxes. No nests were identified near the flagged portion of the rooftop. During three oiling treatments, 885 ring-billed gull nests and 37 herring gull nests were managed. USDA-WS returned to the rooftop on June 7 to remove the previously oiled eggs and remaining nesting material.

Two rooftops nesting sites (Midway1 and Midway2) located on warehouses were in close proximity to Midway International Airport. USDA-WS removed the nests rather than oiling the eggs to promote early abandonment of the sites to decrease the potential risk of gull/aircraft collisions. During a period of four visits to Midway1, 768 ring-billed gull nests and 65 herring gull nests were removed. The greatest number of nests removed during a single visit occurred on May 25 when 340 ring-billed gull nests and 26 herring gull nests were removed. Over a period of four visits to Midway2, 1 ring-billed gull nest and 14 herring gull nests were removed. The greatest number of nests removed during a single visit occurred on May 25 when 1 ring-billed gull nest and 4 herring gull nests were removed.

A total of 1,743 ring-billed gull nests and 307 herring gull nests were removed from the four rooftop colonies (Table 4). While nest removal was in progress, gulls were observed establishing new nests after their initial nests were destroyed. Therefore, it is highly likely that the number of nests removed was greater than the actual colony size.

Observations of gull use of Chicago habitats

Hatch-year gulls were first observed arriving on Chicago beaches on June 25. From this date on, gull use on beaches increased for each of the following five observation periods until it began tapering off during week 11. Between weeks 5-10, 7 of 9 beaches surveyed that were not affected by canine harassment were noted to have a reduction in HY gull use in comparison to 2011. When compared to the initial year of observations in 2007, 8 of 9 beaches exhibited a statistically detectable week by year interaction ($P \leq 0.08$). Additionally, the number of HY gulls observed on the 9 analyzed beaches declined by 94% from 2007 to 2012 (Table 5, Figure 4).

Compared to 2011, beaches without canine harassment activities observed a 12% increase in AHY during 2012 (Table 6, Figure 5). Yet, when compared to the initial year of observations in 2007, a reduction in the number of AHY gulls was observed at 6 of the 9 beaches with a decline of AHY gull use of 8% at the 9 beaches (Table 6).

Although the total number of gulls observed is the sum of the HY and AHY and therefore not independent of its components, it still is important to examine changes since the ultimate success of this project depends on whether or not limiting recruitment can eventually affect an already existing gull population. The mean number of total gulls observed per weekly observation block in 2012 compared to 2007 declined 46%, with all nine beaches indicating a reduction in total gull usage (Table 6, Figure 6). Furthermore, three beaches exhibited a statistically detectable week by year interaction ($P<0.08$) compared to the initial year of observations in 2007 (Table 5).

The effects of increasing our ability to minimize HY production have reduced the total number of gulls using Chicago beaches. During the initial study period in 2007, when 52% of HY gull production was prevented, HY gulls represented 44% of the total number of gulls observed on Chicago beaches during weeks 5-10. In contrast, during 2012 there were 15,976 fewer nests left untreated compared to 2007. As an outcome of reduced HY production from Chicago colonies, the proportion of HY gulls to AHY gulls on Chicago beaches was limited to 4% during 2012 (Table 6).

Canine harassment was conducted at three Chicago beaches during 2012. All three harassment locations influenced gull use differently. At 63rd Street Beach harassment was performed from dawn to dusk. Observations in the morning before canine harassment began, indicated that gulls primarily gathered on the beach and beach parking lot. During 17 observations while canines were not actively deployed, a mean of 280 gulls were observed at the site. Surveys conducted while canines were actively dispersing birds showed that gulls were dispersed off the beach and forced to loaf off-site. While harassment activities were being conducted, a mean of 102 gulls were observed on 63rd Street Beach, in the parking lot, and on nearby piers (Table 7).

Canine harassment was conducted intermittently at 57th Street Beach. When gull harassment was being conducted on 57th Street Beach typically canines would cease deployment at 63rd Street Beach and move to 57th Street Beach. All randomly selected surveys during the 2012 swim season occurred while canine harassment activities were taking place at nearby 63rd Street Beach and not at 57th Street Beach. Therefore, USDA-WS did not conduct an observation at 57th Street Beach while canine harassment activities were taking place. Compared to 2011, 57th Street Beach observed a 74% increase in total gull use during weeks 5-10.

In 2012, intermittent canine harassment took place for the first time at Montrose Beach. During harassment periods, differences in gull use were observed between the public beach and the IBA. During periods of time when canines were not actively dispersing birds on Montrose Beach, the mean number of gulls on the beach and the IBA were 272 and 46 respectively. In contrast, while canine harassment was being conducted gulls observed on the beach and the IBA were 41 and 223 respectively (Table 7). Furthermore, the total gull use at Montrose Beach as a sum decreased by 14% while canines were on duty. While no gulls were directly witnessed leaving Montrose Beach and moving to nearby Foster Beach, changes in gull use observations suggest an open system between the two beaches. While the total number of gulls decreased at Montrose Beach by a weekly mean of 82 gulls (-22%) during weeks 5-10, Foster Beach exhibited an increase of 47 gulls (+80%) during the same time period (Table 8).

Four quality control gull observational surveys were completed by a secondary observer during the swim season. During each of these surveys, estimates of the number of gulls using the locations were within 10% of each other for the number of total gulls observed. Total gull use data recorded by the secondary observer were 3.4%, 5.4%, -2.8%, and -1.7% away from the primary observers' totals.

In addition, few Canada geese were observed using Chicago's beaches during late-March to May (the goose nesting season). However, the number of geese on Chicago beaches increased during their molting period (mid-June to early July). While molting/flightless, geese gathered in large flocks and regularly utilized beaches and nearshore waters.

Frequency of swim advisories on Chicago's beaches

At 14 beaches without canine harassment, water quality test results were reliably compared from egg oiling years with the year before initiating egg oiling (2006). The proportion of water quality tests in 2012 resulting in a swim advisory remained unchanged at 3 beaches, while decreasing at 7 beaches compared to the previous year. The proportion of tests resulting in a swim advisory compared to 2006, the baseline year, declined at 12 of 14 beaches during 2012 (Table 2).

In addition to the 14 monitoring locations mentioned above, water quality testing was carried out at 4 beaches influenced by canine harassment activities during our study period. Table 2 shows years in which canine harassment was conducted full-time or intermittently. The most notable improvement in the proportion of swim advisories issued was experienced at 63rd Street Beach. During the 2008, 2010, 2011, and 2012 swim seasons, the proportion of tests exceeding the recommended threshold during full-time harassment periods, were .06, .21, .11, .23, respectively. During 2006, 2007, and 2008, when canines were not used to disperse gulls full-time at 63rd Street Beach, the proportion of tests exceeding guidelines were .50, .57, and .57, respectively (Table 2). Conversely, for the first time, an intermittent canine harassment program was implemented at Montrose Beach. In comparing swim advisories at Montrose and nearby Foster Beach in 2012 to 2011 (the year before canine harassment was initiated), the proportion of water quality tests requiring an issuance of a swim advisory increased at both beaches (Table 2).

DISCUSSION

As an outcome of the Chicago Ring-Billed Gull Damage Management Project, it has been established that managing HY gull recruitment at local gull colonies can have a significant effect on the number of HY gulls existing within a local gull community during a swim season. Nest management during 2012, accompanied by identifying previously unknown colonies through aerial surveys, significantly reduced the number of HY gulls contributing to conflicts in Chicago.

The total number of ring-billed gulls nesting in Chicago at the identified colonies also decreased in 2012. For the second time in the past three years, birds elected not to utilize the Lake Calumet dike as a nesting site. As a result, combined total nests at the Dime Pier and Lake Calumet colonies declined by 44%. Weekly visits to the Lake Calumet colony confirmed birds were arriving at the site prior to the nesting season. However possibly due to the warm spring, we believe that the vegetation on the dike grew quickly to a height which exceeded ideal nesting conditions for the birds.

While the number of gulls nesting at the two primary colonies decreased during 2012, we feel that our effectiveness in managing gulls nesting in the City of Chicago was not hindered. Through the use of aerial surveys during the past two nesting seasons, we successfully located four new nesting sites. Furthermore, in 2012 approximately 770 km² was carefully searched in Cook County via aerial surveys for potential nesting locations.

In 2011, property managers at the Jardine Water Purification Plant were concerned about the large number of gulls nesting on their roof and the accumulation of fecal material that was being deposited on their property. In an effort to discourage nesting, flagging tape and avian distress call boxes were installed on portions of the roof prior to the nesting season in 2012. After the nesting season began, 885 ring-billed gull and 37 herring gull nests were identified and managed on the site. At this time it was evident that the use of flagging tape was an effective tool in discouraging nesting where the flagging tape was employed. However,

the avian distress call boxes appeared to be an ineffective deterrent to nesting. Not only were multiple nests located in close proximity to the call boxes, on one occasion a herring gull incorporated the call box into its nest. In 2013, property managers are expected to expand the locations where flagging tape is implemented to discourage nesting. Additionally, the two rooftops nesting sites located via aerial surveys in 2011 (Midway1 and Midway2) which are both located within the critical flight path of Midway International Airport were managed to promote abandonment of the sites. Therefore, it is highly likely that the gulls that utilized these three rooftop properties during the 2012 nesting season will be displaced to new locations within the city in 2013.

Management of ring-billed gull nests has contributed to a significant reduction in HY gull use of Chicago beaches. HY gull use of beaches has declined by 94%, with a significant reduction evident at 8 of 9 analyzed beaches. A certain benefit of limiting HY gull production during our six year study period has been lessening the recruitment and potential growth of the AHY gull population. It is highly likely that without management efforts the number of AHY gulls in Chicago would have increased comparatively to population growth trends of ring-billed gulls that have been observed in other Great Lakes regions. Between 2007 and 2012, 84,745 ring-billed gull nests were rendered inviable. It is estimated that the average fledge rate of young ranges between 0.80 to 1.9 per nest (Mousseau 1984, Brown and Morris 1994, Brown and Morris 1996). Therefore, it is reasonable to believe that since the initiation of this project, between 67,796 and 161,015 hatch-year ring-billed gulls have been prevented.

Observations of HY and AHY gull use of beaches illustrates a combined reduction in gulls compared to 2007 observation totals. The mean number of total gulls observed declined 46%, with data at all nine beaches showing a reduction in total gull usage.

Canine harassment has been a valuable tool in reducing the number of gulls and their associated excrement on the beaches. The continued canine management activity at 63rd Street Beach has improved water quality while limiting gull activity. However, there is potential that canine harassment may displace gulls from one location to another and therefore, there is a greater likelihood of increasing gull activity at non-harassment beaches.

An additional year of egg oiling, combined with fewer gulls nesting in Chicago, would lead to the expectation that fewer total gulls would be observed on all Chicago's beaches. However, due to changes of circumstance (canine harassment at Montrose Beach) not every location observed the anticipated reduction in total gull use. Most notable was at Foster Beach, where the total number of gulls increased by 74% (Table 6). The additional gull activity at Foster Beach is likely due to its close proximity to Montrose Beach. Observations conducted at Montrose and Foster Beaches suggest that during harassment periods at Montrose Beach, gulls were displaced to either the nearby IBA or Foster Beach. While it is unclear if harassment activities at Montrose Beach adversely affected the number of swim advisories issued, it is possible that variations in loafing locations may have had a negative effect on water quality and an increase in FIB. During non-harassment periods, the undisturbed gulls at Montrose Beach were often dispersed across a large area of dry foreshore sand, away from the nearshore. Conversely, while canine harassment activities were engaged, gulls found refuge on the IBA and were massed together on a narrow section of beach typically in the swash-zone.

Many actions have been taken to improve sand and water quality on Chicago beaches in an effort to reduce the number of swim advisories. When comparing swim advisories in the base year (2006) to swim advisories in 2012, a reduction in the proportion of tests exceeding U.S. EPA guidelines were observed at 12 of 14 beaches.

While a relationship between gulls and increased FIB at beaches has been identified, the complete interaction between gulls and water quality is multifaceted and not entirely understood. Furthermore, each beach has its own set of variables that influences water quality, so it is unrealistic to attempt to decipher whether or not variations in gull use at a beach may have altered the amount of gull fecal matter necessary to effect the testing results for FIB for an individual beach on a particular day.

Nevertheless, over the duration of this project, a detectible reduction in the number of gulls and the volume of gull excrement on beaches has been documented. Reductions in swim advisories suggest that on several occasions, the amount of gull fecal matter may have been reduced to a tolerable level below the

threshold that would result in a swim advisory on a specific day. According to Converse et al. (2012), 50% reduction in the number of gulls on a beach can result in a detectible decrease in *E. coli* densities.

Additionally, Canada geese congregated in large flocks on beaches and in nearshore waters while molting/flightless in June and July. In an avian damage management being conducted simultaneously as the this gull damage management project, applications of the Anthraquinone based chemical repellent FlightControl® PLUS (FCP) was effective in limiting goose foraging near 12th Street, 63rd Street, Montrose, Rainbow, and South Shore beaches (Glen Dunn, USDA-WS, personal communication, December 15, 2012).

CONCLUSION AND NEXT STEPS

While the regional ring-billed gull population has grown exponentially, nest management activities in Chicago have proven to be an effective method in reducing the number of gulls contributing to conflicts in the City of Chicago. As a result of limiting annual production of ring-billed gulls, the number of HY gulls utilizing Chicago beaches has declined by 94%, while the total number of gulls utilizing beaches demonstrated a 46% reduction between 2007 and 2012.

It is encouraging that conflicts (such as reductions in swim advisories) may have declined as a result of the reduction in the total number of gulls utilizing Chicago beaches. With the information known about gulls and their role in the accumulation of fecal coliform at beaches, future nest management efforts are warranted as a method to protect water quality.

Although the Integrated Ring-billed Gull Damage Management Project has unquestionably limited the recruitment of HY gulls into the existing colonies, gulls are long-lived and the population of breeding-age adults has not likely decreased appreciably. Through on-going research, it appears that AHY gulls may disperse widely after the nesting season. However, the range of HY gulls appears to be somewhat limited after fledging and their foraging and loafing locations during the swim season is likely confined to sites near their natal colonies. Annual management of HY gull production at nearby colonies should continue to limit HY gull use of Chicago beaches. Due to high colony site fidelity, efforts to limit production of ring-billed gulls should also avoid a rapid influx of second-year birds during the following nesting season. Additionally, we are hopeful that continued egg depredation should eventually produce an observable downward trend in beach usage by AHY birds as the adult population declines through natural attrition.

Further, the influences that canine harassment has on movement patterns of displaced gulls are relatively unknown. While these efforts may prove effective at the particular application beach, little is known about the effects of harassment on surrounding beaches. Therefore, during the 2013 beach season, we propose a project that will include the deployment of satellite transmitters on ring-billed gulls that utilize canine harassment beaches. We are hopeful we can gain new information on the movements of gulls on and around harassment beaches that will allow beach managers to make educated decisions regarding future management of ring-billed gulls.

Significant numbers of Canada geese were observed using beaches and nearshore water during June and July. Continued applications of the chemical repellant FCP would likely continue to be effective in limiting goose use of 12th Street, 63rd Street, Montrose, Rainbow, and South Shore beaches. We believe applications of FCP in grass areas adjacent to 31st Street Beach may also reduce goose presence in the area and reduce the goose fecal droppings in the sensitive environment.

At beach locations with a large presence of geese the use of molecular source tracking for identification between gulls and geese can be useful to detect the contributing sources of fecal contamination of beach waters. The U.S. EPA has recognized molecular source tracking as a method to verify sources of fecal contamination identified during sanitary surveys (U. S. EPA. 2012). Furthermore, Hamilton et al. (2006) suggest that specific DNA goose markers may provide a cost-effective way to detect and quantify sources of E. coli strains in water quality analyses.

ACKNOWLEDGEMENTS

The authors wish to thank the Chicago Park District for their partnership and continued support on this project. We also appreciate the Illinois International Port District, the US Army Corps of Engineers, the Chicago Department of Water Management, and private property owners for granting us permission to access their property to conduct this project. Funding was provided by the U.S. Environmental Protection Agency through the Great Lakes Restoration Initiative under the direction of the Chicago Park District.

LITERATURE CITED

Belant, J. L., S. K. Ickes, and T. W. Seamans. 1998. Importance of landfills to urban nesting herring and ring-billed gulls. Landscape and Urban Planning 43: 11 – 19.

Blackwell, B. F., T. W. Seamans, D. A. Helon, and R. A. Dolbeer. 2000. Early loss of herring gull clutches after egg-oiling. Wildlife Society Bulletin 28: 70 – 75.

Brown, K. M. and R. D. Morris. 1994. The influence of investigator disturbance on the breeding success of Ring-billed Gulls (Larus delawarensis). Colonial Waterbirds 17: 7 – 17.

Brown, K. M. and R. D. Morris. 1996. From tragedy to triumph: Renesting in Ring-billed-gulls. Auk 113: 23 – 31.

Canadian Wildlife Service. 1975. Gull seminar proceedings. Canadian Wildlife Service, Sackville, New Brunswick.

Conover, M. R., W. C. Pitt, K. K. Kessler, T. J. Dubow, and W. A. Sanborn. 1995. Review of human injuries, illnesses and economic-based losses caused by wildlife in the United States. Wildlife Society Bulletin 23:407 – 414.

Converse, R. R., J. L. Kinzelman, E. A. Sams, E. Hudgens, A. P. Dufour, H. Ryu, J.W. Santo-Domingo, C. A. Kelty, O. C. Shanks, S. D. Siefring, R. A. Haugland, and T. J. Wade. 2012. Dramatic Improvements in Beach Water Quality Following Gull Removal. Environmental Science and Technology 46:10206 − 10213.

Costello, D. F. 1971. The world of the gull. Lippincott Co., Philadelphia and New York.

Cutbert, F. J., J. McKearnan, L. R. Wires, and A. Joshi. 2003. Distribution and abundance of colonial waterbirds in the U.S. Great Lakes: 1997-1999. Draft 16. Report to the U.S. Fish and Wildlife Service.

Darling, L. 1965. The gull's way. William Morrow and Co., New York.

Dolbeer, R. A., S. E. Wright, and E. C. Cleary. 1995. Bird and other wildlife strikes to civilian aircraft in the U. S., 1994 Interim report DTFA01-91-Z-02004. USDA for FAA, FAA Technical Center, Atlantic City, New Jersey. P8. Federal Aviation Administration Wildlife Strike Database. 2007. http://wildlife.pr.erau.edu/public/

Dolbeer, R. A., S. E. Wright, J. Weller, and M. J. Begier. 2012. Wildlife strikes to civilian aircraft in the U. S. 1990-2011. Federal Aviation Administration National Wildlife Strike Database Serial Report Number 18. Report of the Associate Administrator of Airports. Washington, DC.

Edge, T. A. and S. Hill. 2007. Multiple lines of evidence to identify the sources of fecal pollution at a freshwater beach in Hamilton Harbour, Lake Ontario. Water Research 41:3585 – 3594.

Fetterolf, P. M. 1983. Effects of investigator activity on ring-billed gull behavior and reproductive performance. Wilson Bulletin 95:23 – 41.

Gabrey, S. W. 1996. Migration and dispersal in Great Lakes ring-billed and herring gulls. Journal of Field Ornithology 67:327 – 339.

Godfrey, W. E. 1966. Birds of Canada. National Museums of Canada, Ottawa.

Graham, F., Jr. 1975. Gulls. A social history. Random House, New York.

Hadidian, J., G. R. Hodge, and J. W. Grandy. 1997. Wild Neighbors: the humane approach to living with wildlife. Fulcrum Publishing, Golden, Colorado.

Hamilton, M. J., T. Yan, M. J. Sadowsky. 2006. Development of goose and duck specific DNA markers to determine sources of *Escherichia coli* in waterways. Applied and Environmental Microbiology 72:4012–4019

Hansen, D. L., S. Ishii, M. J. Sadowsky, R. E. Hicks. 2011. Waterfowl abundance does not predict the dominant avian source. Journal of Environmental Quality 40:1924 – 1931.

Hartmann, J. W., S. F. Beckerman, T. W. Seamans, R. M. Engeman, S. Abu-Absi. 2010. Report to the City of Chicago on conflicts with ring-billed gulls and the 2009 integrated ring-billed gull damage management project (Prepared for Chicago Department of Environment) Springfield, IL: USDA/APHIS/Wildlife Services.

Hartmann, J. W., S. F. Beckerman, R. M. Engeman, T. W. Seamans, S. Abu-Absi. 2012. Report to the City of Chicago on conflicts with ring-billed gulls and the 2011 integrated ring-billed gull damage management project (Prepared for Chicago Department of Environment) Springfield, IL: USDA/APHIS/Wildlife Services.

Ickes, S. K., J. L. Belant, and R. A. Dolbeer. 1998. Nest disturbance techniques to control nesting by gulls. Wildlife Society Bulletin 26:269 – 273.

Illinois Department of Public Health. (2010) Beach Monitoring Web Site. Retrieved from http://app.idph.state.il.us/envhealth/ilbeaches/public/

Lake County Board. (2004) Lake County Regional Framework Plan. Lake County, Illinois. Retrieved from www.co.lake.il.us/health

Kinzelman, J., S. L. McLellan, A. Amick, J. Preedit, C. O. Scopel, O. Olapade, S. Gradus, A. Singh, and G. Sedmak. 2008. Identification of human enteric pathogens in gull feces at Southwestern Lake Michigan bathing beaches. Canadian Journal of Microbiology 54:1006 - 1015.

Kinzelman, J., S. L. McLellan, A. Daniels, S. Cashin, A. Singh, S. Gradus, and R. Bagley. 2004. Non-point Source Pollution: Determination of Replication versus Persistence of Escherichia coli in Surface Water and Sediments with Correlation of Levels to Readily Measurable Environmental Parameters. Journal of Water Health 2:103 – 114.

Linnell, M. A., M. R. Conover, and T. J. Ohashi. 1996. Analysis of bird strikes at a tropical airport. Journal of Wildlife Management 60:935 – 945.

Linnell, M.A., M. R. Conover, and T. J. Ohashi. 1999. Biases in bird strike statistics based on pilot reports. Journal of Wildlife Management 63:997 – 1003.

Levesque, B.; P. Brousseau, F. Bernier, E. Dewailly, and J. Joly. 2000. Study of the bacterial content of ring-billed gull droppings in relation to recreational water quality. Water Research 34:1089 – 1096.

Ludwig, J. P. 1974. Recent changes in the ring-billed gull population and biology in the Laurentian Great Lakes. Auk 91:575 – 594.

Maxson, S. J., and K. V. Haws. 2000. Population Studies of Piping Plovers at Lake of the Woods, Minnesota: 19 Year History of a Declining Population. Waterbirds: 23:475 – 481.

Morris, R. D., I. R. Kirkham, and J. W. Chardine. 1980. Management of a declining Common Tern colony. Journal of Wildlife Management 44:241 – 245.

Mousseau, P. 1984. A comparison of two methods to assess the breeding success of Ring-billed Gulls. Journal of Field Ornithology 55: 151 – 159.

Nol, E., and H. Blokpoel. 1983. Incubation period of ring-billed gulls and the egg immersion technique. Wilson Bulletin 95: 283 – 286.

Nugent, B., K. Gagne, and M. J. Dillingham. 2008. Managing gulls to reduce fecal coliform bacteria in a municipal drinking water source. Proceedings of the Vertebrate Pest Conference 23: 26 – 30.

Olijnyk, C. G., and K. M. Brown. 1999. Results of a seven year effort to reduce nesting by herring and great black-backed gulls. Waterbirds 22: 285 – 289.

Pochop, P A., J. L. Cummings, C. A. Yoder, and J. E. Steuber. 1998. Comparison of white mineral oil and corn oil to reduce hatchability in ring-billed gull eggs. Proceedings of the Vertebrate Pest Conference 18: 411 – 413.

RTI International. 2011. Bacteria TDMLs for Illinois' Lake Michigan Beaches Options Summary report. Task Order 2010-25, Report to the U.S. Environmental Protection Agency.

Ryder, J. P. 1993. Ring-billed gull. In The birds of North America, No. 33 (A. Poole, P. Stettenheim, and F. gill, Eds.). Philadelphia: The Academy of Natural Sciences; Washington, DC: The American Ornithologists' Union.

Sauer, J. R., J. E. Hines, J. E. Fallon, K. L. Pardieck, D. J. Ziolkowski, Jr., and W. A. Link. 2011. The North American Breeding Bird Survey, Results and Analysis 1966 - 2010. Version 12.07.2011

Schreiber, E., and R. W. Schreiber. 1975. Wonders of sea gulls. Dood Mead and Co., New York.

Soucie W.T., and M. A. Pfister. 2003. E. coli source identification on Lake Michigan Beaches in Lake County, Illinois. Great Lakes Beach Association Annual Meeting.

U. S. EPA. 2012. Recreational Water Quality Criteria. Office of Water: EPA-820-F-12-058.

Vermeer, K. 1970. Breeding biology of California and Ring-billed Gulls: a study of ecological adaptations to the inland habitat. Report Series Number 12. Environment Canada, Canadian Wildlife Service, Ottawa.

Weseloh, D. V. 1984. The origins of banded Herring Gulls recovered in the Great Lakes region. Journal of Field Ornithology 55:190 – 195.

Whitman, R. L., and M. B. Nevers. 2003. Foreshore sand as a source of *Escherichia coli* in nearshore water of a Lake Michigan beach. Applied and Environmental Microbiology 69:5555 – 5562.

Whitman, R. L., M. B. Nevers, G. C. Korinek, and M. N. Byappanahalli. 2004. Solar and temporal effects on *E. coli* concentration at a Lake Michigan swimming beach. Applied and Environmental Microbiology 70: 4276 – 4285.

Wright, S. 2010. Some Significant Wildlife Strikes to Civil Aircraft in the United States (1990 - April 2010). US Department of Agriculture/Animal and Plant Health Inspection Service/Wildlife Services. Sandusky, OH. May 5, 2010.

Table 1. Number of ring-billed gull observation surveys within week blocks in 2007 through 2012 field seasons in Chicago, Illinios.

Block	Dates	Number of Observations					
		2007	2008	2009	2010	2011	2012
1	5/27-6/2	3	0	3	3	3	3
2	6/3-6/9	3	0	3	3	3	3
3	6/10-6/16	2	1	3	3	3	3
4	6/17-6/23	3	7	3	3	3	3
5 [a]	6/24-6/30	3	6	3	3	3	3
6 [a]	7/1-7/7	2	4	3	3	3	3
7 [a]	7/8-7/14	2	5	3	3	3	3
8 [a]	7/15-7/21	3	4	3	3	3	3
9 [a]	7/22-7/28	2	4	3	3	3	3
10 [a]	7/29-8/4	1	3	3	3	3	3
11	8/5-8/11	0	3	3	3	3	3
12	8/12-8/18	0	3	3	3	3	3
13	8/19-8/25	0	3	3	3	3	3
14	8/26-9/1	0	2	3	3	3	3
15	9/2-9/9	0	1	3	3	3	3

[a]Hatch-year and after hatch-year gull analysis conducted on observation blocks 5-10

Table 2. The proportion of water samples on Chicago's beaches from 2006 – 2012 that exceeded established water quality standards[1], where 2006 represents a pre-egg oiling treatment baseline year.

Beach	Proportion of tests resulting in swim advisories or bans						
	2006	2007	2008	2009	2010	2011	2012
Juneway	0.09	0.10	0.14	0.03	0.04	0.06	0.07
Rogers	0.08	0.07	0.12	0.03	0.04	0.06	0.04
Howard	0.08	0.08	0.13	0.03	0.09	0.07	0.04
Jarvis/Fargo	0.08	0.11	0.11	0.01	0.10	0.06	0.12
Leone/Loyola	0.13	0.08	0.07	0.08	0.07	0.07	0.07
Hollywood/Osterman	0.18	0.16	0.10	0.12	0.19	0.11	0.09
North Avenue	0.11	0.20	0.00	0.06	0.03	0.08	0.05
Oak Street	0.09	0.21	0.04	0.03	0.11	0.05	0.00
Ohio Street	0.13	0.18	0.09	0.11	0.07	0.14	0.07
12th Street	0.22	0.10	0.07	0.15	0.13	0.15	0.15
31st Street	0.27	0.41	0.17	0.13	0.21	0.17	0.21
South Shore	0.21	0.26	0.15	0.16	0.31	0.22	0.16
Rainbow	0.22	0.41	0.19	0.27	0.24	0.24	0.30
Calumet	0.28	0.41	0.17	0.23	0.22	0.16	0.16

Beach	Proportion of tests resulting in swim advisories or bans at canine harassment locations						
	2006	2007	2008	2009	2010	2011	2012
Foster	0.19[2]	0.21[2]	0.14	0.08	0.10	0.04	0.11
Montrose	0.24	0.28	0.25	0.23	0.21	0.23	0.25[2]
57th Street	0.23	0.26	0.00[3]	0.33	0.13[2]	0.14[2]	0.15[2]
63rd Street	0.50	0.57[2]	0.06[3]	0.57	0.21[3]	0.11[3]	0.23[3]

1. Swim advisories and bans from Illinois Department of Public Health Database http://app.idph.state.il.us/envhealth/ilbeaches/public/
2. Intermittent canine harassment.
3. Full-time canine harassment.

Table 3. Estimated number of ring-billed gull nests and eggs oiled at Dime Pier/DuSable Harbor Breakwall and Lake Calumet, Chicago, Illinois, in 2007 through 2012.

	Total Number of Ring-billed Gull Nests						Number of Nests Removed or Oiled						Number of Eggs Removed or Oiled					
	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012	2007	2008	2009	2010	2011	2012
Dime Pier/ DuSable Harbor Breakwall	3,797	4,727	4,668	5,292	5,139	4,795	3,470	3,773	3,750	3,954	4,223	4,055	8,764	9,554	8,889	10,285	10,398	10,408
Lake Calumet	31,395[1]	22,918	21,355	0	3,454	6	15,000	18,363	17,391	0	2,933	0	41,753	48,036	41,244	0	6,663	0
Total	35,192	27,645	26,023	5,292	8,593	4,801	18,470 (52)[2]	22,136 (80)	21,141 (81)	3,954 (75)	7,156 (83)	4055 (84)	50,517	57,590	50,133	10,285	17,061	10,408

[1] 2007 nests totals were estimated for Lake Calumet.

[2] Estimated percentage of nests oiled.

Table 4. Number of ring-billed gull and herring gull nests and eggs removed or treated at rooftop colonies during 2012.

Number of Nests and Eggs Removed or Treated					
Site Name	Location	Ring-billed gull		Herring gull	
		Nests	Eggs	Nests	Eggs
Jardine Water Purification Plant	Chicago	885	2058	37	104
Midway1[1]	Chicago	768	1486	65	142
Midway2[1]	Chicago	1	2	14	27
Lincolnwood[1]	Lincolnwood	89	200	191	515
Totals		1743	3746	307	788

[1] Nests and eggs reported are greater than the actual colony size due to gulls re-nesting during the removal period.

Table 5. P value of year by week interaction between 2007, 2008, 2009, 2010, 2011, and 2012 hatch-year, after hatch-year, and total ring-billed gull use of beaches without canine harassment during weeks 5-10.

Beach	Hatch-Year			After Hatch-Year			Total		
	year	week	yr*wk	year	week	yr*wk	year	week	yr*wk
Leone/Loyola	<.0001	<.0001	.0254	<.0001	.76	.61	.0006	.0953	.80
Hollywood/Osterman	<.0001	<.0001	<.0001	<.0001	.0040	.58	<.0001	<.0001	.30
North Avenue	<.0001	<.0001	.0003	.39	<.0001	.0754	.0248	<.0001	.16
Oak Street	<.0001	<.0001	<.0001	.12	.0287	.0435	.0542	.0049	.0151
Ohio Street	.62	.0337	.0911	.76	.24	.23	.76	.22	.19
12th Street	<.0001	.0002	.0334	.0334	.68	.0637	.0126	.92	.11
31st Street	<.0001	<.0001	<.0001	<.0001	.77	.95	<.0001	.33	.79
Rainbow	<.0001	<.0001	<.0001	.0131	.10	.16	<.0001	.34	.0300
Calumet	<.0001	<.0001	<.0001	.74	.0162	.69	<.0001	<.0001	.0010

Table 6. Mean number of hatch-year, after hatch-year, and total ring-billed gulls observed per observational survey on beaches without canine harassment in Chicago, Illinois during weeks 5-10 of the observation period in 2007 through 2012. Percentage change for 2008 through 2012 in comparison to 2007 are shown in parentheses.

Beach	Year	Hatch-Year	After Hatch-Year	Total
Leona/Loyola	2007	41.7	79.2	120.9
	2008	16.1(-62)	71.1(-10)	87.1(-28)
	2009	8.8(-79)	114.4(44)	123.2(2)
	2010	11.9(-72)	58.3(-26)	70.2(-42)
	2011	5.1(-88)	68.8(-13)	73.9(-39)
	2012	1.8(-96)	113.8(44)	115.6(-4)
Hollywood/ Osterman	2007	114.1	204.4	318.5
	2008	22.2(-81)	216.0(06)	238.2(-25)
	2009	6.8(-94)	161.8(-21)	168.6(-47)
	2010	11.4(-90)	121.7(-40)	133.1(-58)
	2011	5.1(-96)	98.3(-52)	103.4(-68)
	2012	3.9(-97)	134.3(-34)	138.2(-57)
North Avenue	2007	83	155.7	238.7
	2008	12.2(-85)	130.2(-16)	142.5(-40)
	2009	9.7(-88)	145.0(-07)	154.7(-35)
	2010	15.6(-81)	161.5(4)	177.1(-26)
	2011	9.5(-89)	173.4(11)	182.9(-23)
	2012	2.8(-97)	160.0(3)	162.8(-32)
Oak Street	2007	4.1	13.2	17.3
	2008	0.4(-91)	7.2(-45)	7.6(-56)
	2009	0.6(-85)	15.8(20)	16.4(-5)
	2010	1.2(-71)	7.8(-41)	9.0(-48)
	2011	0.7(-83)	8.9(-33)	9.6(-45)
	2012	0.2(-96)	6.6(-50)	6.8(-61)
Ohio Street	2007	0.4	5.9	6.3
	2008	0.3(-26)	4.3(-26)	4.6(-26)
	2009	0.1(-87)	4.4(-25)	4.4(-29)
	2010	0.3(-20)	7.2(23)	7.6(20)
	2011	0.2(-50)	7.1(20)	7.3(16)
	2012	0.3(-33)	5.7(-3)	5.9(-5)

Beach	Year	Hatch-Year	After Hatch-Year	Total
12th Street	2007	28.9	57.8	86.8
	2008	16.3(-44)	82.3(42)	98.6(14)
	2009	9.8(-66)	41.8(-28)	51.6(-41)
	2010	7.9(-73)	37.6(-35)	45.4(-48)
	2011	4.8(-83)	47.1(-19)	51.9(-40)
	2012	8.3(-71)	67.7(17)	76.0(-12)
31st Street	2007	86.3	93.3	179.5
	2008	28.1(-67)	129.9(39)	158.0(-12)
	2009	17.3(-80)	139.7(50)	156.9(-13)
	2010	16.1(-81)	47.3(-49)	63.4(-65)
	2011	12.1(-86)	89.3(-4)	101.4(-44)
	2012	3.1(-96)	54.4(-42)	57.5(-68)
Rainbow	2007	137.9	183.2	321.1
	2008	39.4(-71)	263.4(44)	302.9(-6)
	2009	28.7(-79)	186.1(2)	214.8(-33)
	2010	33.9(-75)	190.4(4)	224.4(-30)
	2011	13.3(-90)	153.3(-16)	166.6(-48)
	2012	10.5(-92)	182.1(-1)	192.6(-40)
Calumet	2007	180.1	84.8	264.9
	2008	38.3(-79)	56.3(-34)	94.6(-64)
	2009	17.4(-79)	63.6(-25)	80.9(-69)
	2010	27.8(-85)	60.7(-28)	88.4(-67)
	2011	10.2(-94)	74.3(-12)	84.6(-68)
	2012	6.6(-96)	79.6(-6)	86.2(-67)
Total	2007	676.5	877.4	1553.9
	2008	173.3(-74)	960.8(9)	1134.1(-27)
	2009	99.1(-85)	872.5(-1)	971.6(-37)
	2010	126.1(-81)	692.6(-21)	818.6(-47)
	2011	60.9(-91)	720.7(-18)	781.6(-50)
	2012	37.3(-94)	804.2(-8)	841.6(-46)

Table 7. Mean number of total ring-billed gulls observed at 63rd Street beach and Montrose beach with and without canine harassment in Chicago, Illinois during 2012.

Gulls Observed at 63rd Street Beach		
Location	Non-harassment (*n*=17)	Harassment (*n*=41)
Nearshore[1]	0.4	2.5
Park[1]	70.2	4.6
Beach[2]	128.3	30.2
Casino Pier[2]	59.1	26.6
59th Street Pier[2]	22.3	39.1
Total	280.2	102.9

Gulls Observed at Montrose Beach		
Location	Non-harassment (*n*=9)	Harassment (*n*=34)
Nearshore[1]	3.8	3.0
Park[1]	0.0	9.8
Beach[2]	272.3	41.1
IBA[1]	45.8	222.5
Total	321.9	276.4

[1] Canines did not have access to this area.
[2] Canines had access to this area.

Table 8. Mean number of hatch-year, after hatch-year, and total ring-billed gulls observed per observational survey at locations influenced by canine harassment in Chicago, Illinois during weeks 5-10 of the observation period in 2007 through 2012. Percentage change for 2008 through 2012 in comparison to 2007 are shown in parentheses.

Beach	Year	Hatch-Year	After Hatch-Year	Total
Foster	2007	45.9	71.2	117.1
	2008	34.3(-25)	162.1(128)	196.3(68)
	2009	7.6(-83)	130.2(83)	137.8(18)
	2010	9.9(-78)	86.6(22)	96.5(-18)
	2011	3.4(-93)	59.3(-17)	62.7(-46)
	2012	2.7(-94)	106.4(50)	109.2(-7)
Montrose	2007	205.5	314.8	520.3
	2008	46.6(-77)	313.3(0)	360.0(-31)
	2009	20.0(-90)	222.7(-29)	242.7(-53)
	2010	36.0(-82)	294.3(-7)	330.3(-37)
	2011	19.8(-90)	350.1(11)	369.9(-29)
	2012	8.2(-96)	281.6(-11)	289.7(-44)
Montrose Harbor	2007	33.0	58.7	91.6
	2008	9.6(-71)	37.9(-35)	47.5(-48)
	2009	7.4(-77)	52.6(-10)	60.1(-34)
	2010	9.3(-72)	57.1(-3)	66.4(-28)
	2011	2.7(-92)	35.7(-39)	38.4(-58)
	2012	4.1(-88)	89.4(52)	93.6(2)

Beach	Year	Hatch-Year	After Hatch-Year	Total
57th Street	2007	109.5	121.3	230.8
	2008	1.3(-99)	3.6(-97)	4.9(-98)
	2009	14.2(-87)	96.0(-21)	110.2(-52)
	2010	15.5(-86)	92.8(-24)	108.3(-53)
	2011	6.9(-94)	54.8(-55)	61.8(-73)
	2012	2.4(-98)	109.1(-10)	111.4(-52)
63rd Street	2007	65.0	170.6	235.6
	2008	0.5(-99)	3.5(-98)	4.0(-98)
	2009	35.5(-45)	252.7(48)	288.2(22)
	2010	2.8(-96)	21.6(-87)	24.3(-90)
	2011	4.5(-93)	85.2(-50)	89.7(-62)
	2012	1.6(-98)	33.7(-80)	35.3(-85)
Jackson Harbor	2007	34.6	125.2	159.8
	2008	15.7(-55)	106.5(-15)	122.2(-24)
	2009	16.1(-53)	105.7(-16)	121.8(-24)
	2010	14.2(-59)	130.8(5)	145.0(-9)
	2011	2.3(-93)	64.9(-48)	67.2(-58)
	2012	1.6(-96)	115.1(-8)	116.6(-27)

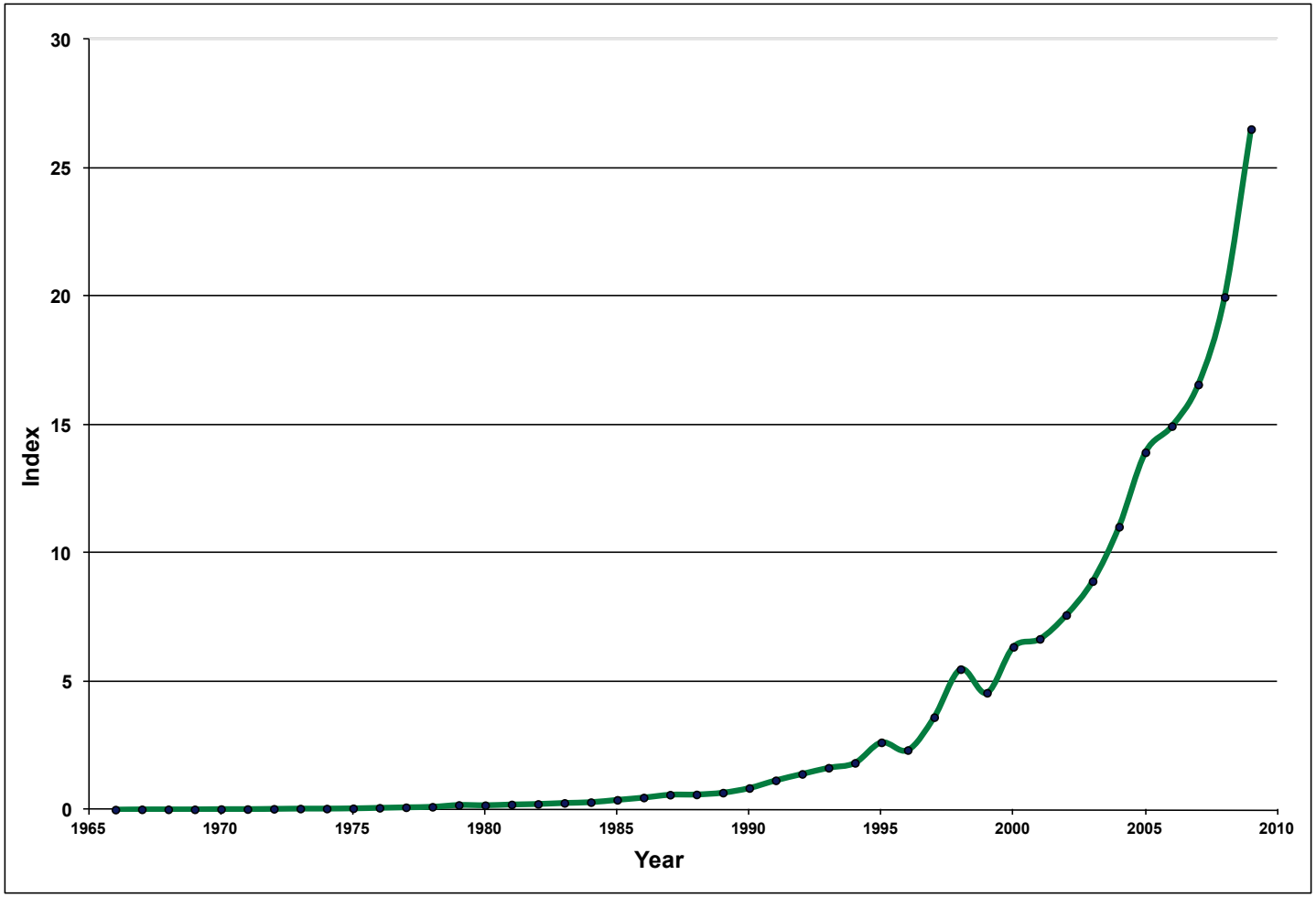


Figure 1. Breeding Bird Survey annual population indices for ring-billed gulls in Illinois from 1966-2009 from Sauer et al. (2011).

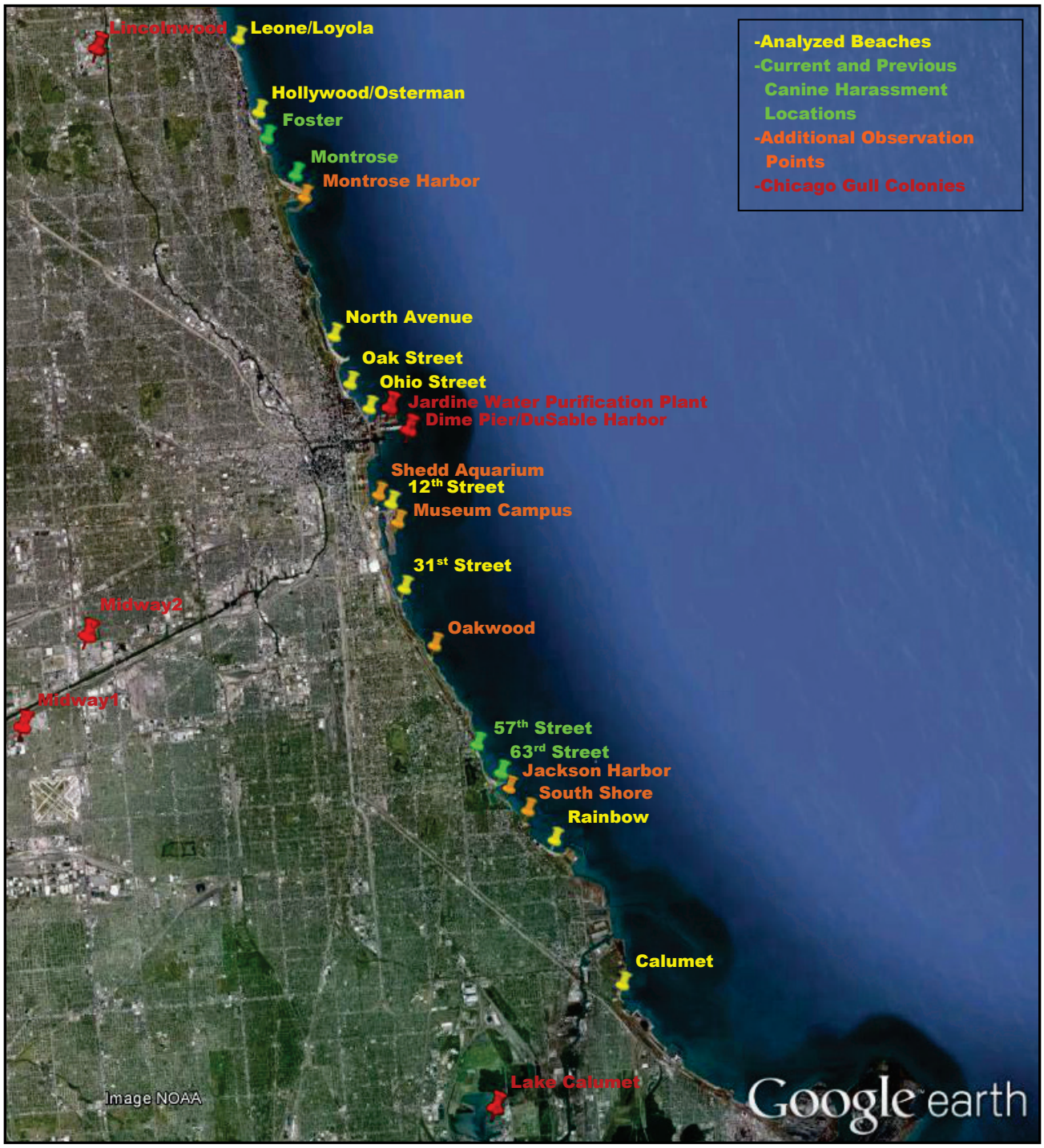
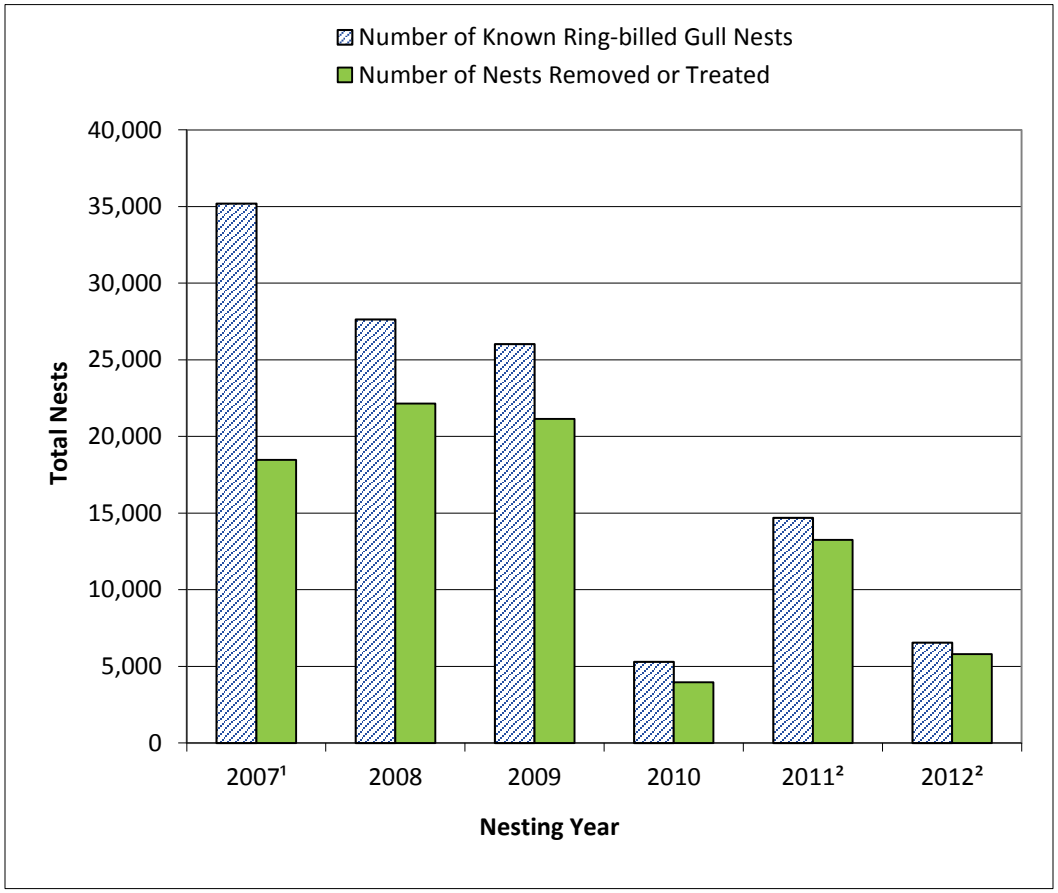
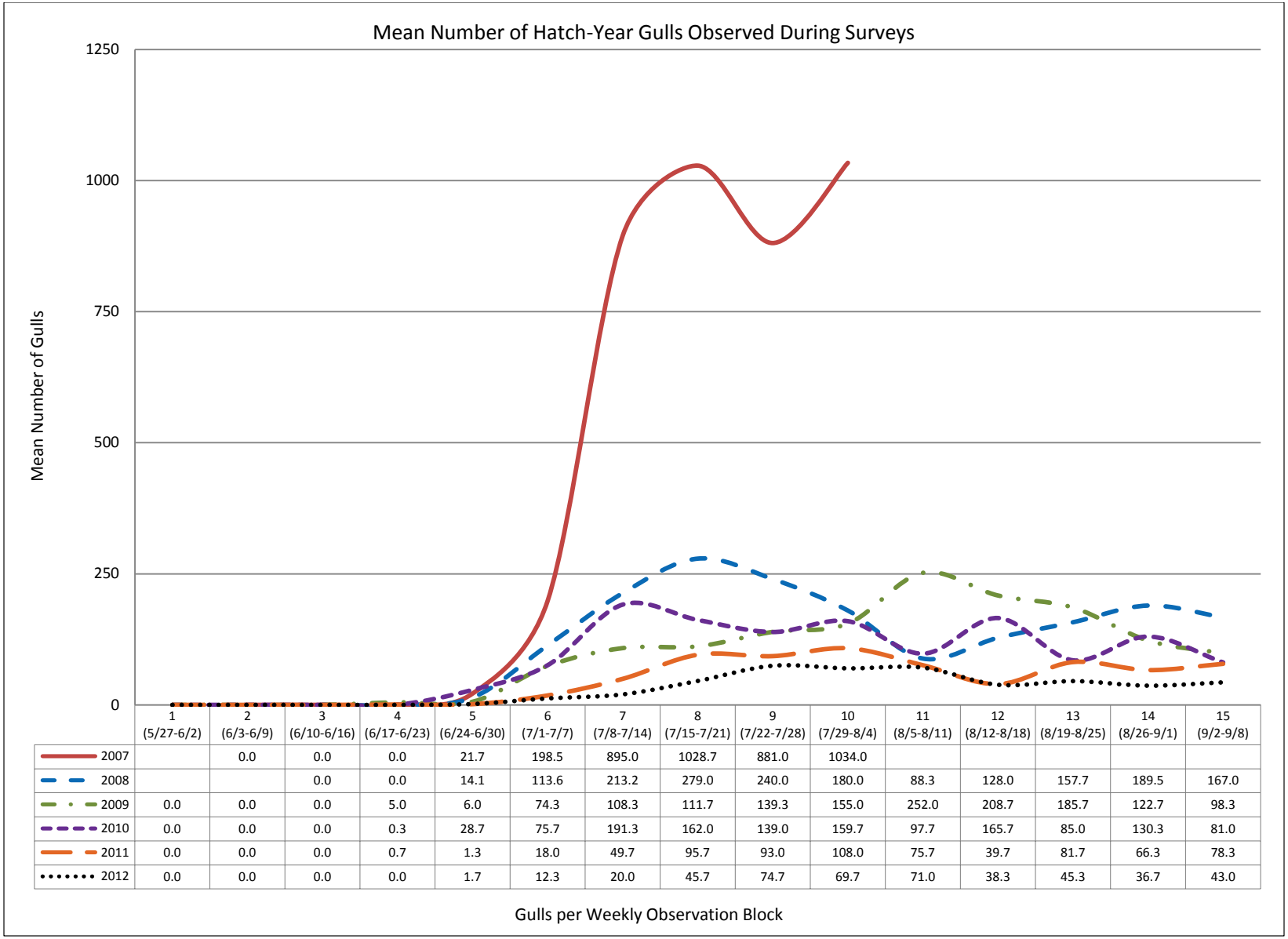


Figure 2. Observation points in Chicago, Illinois and ring-billed gull colony locations (Map courtesy of Google Earth).



[1] 52 percent of the total nests in 2007 were estimated. During 2008 through 2012 all nests were physically counted.
[2] The "Number of Known Ring-billed Gull Nests" and "Number of Nests Removed or Oiled" in 2011 and 2012 is likely greater than the actual colony size due to gulls renesting during the removal period.

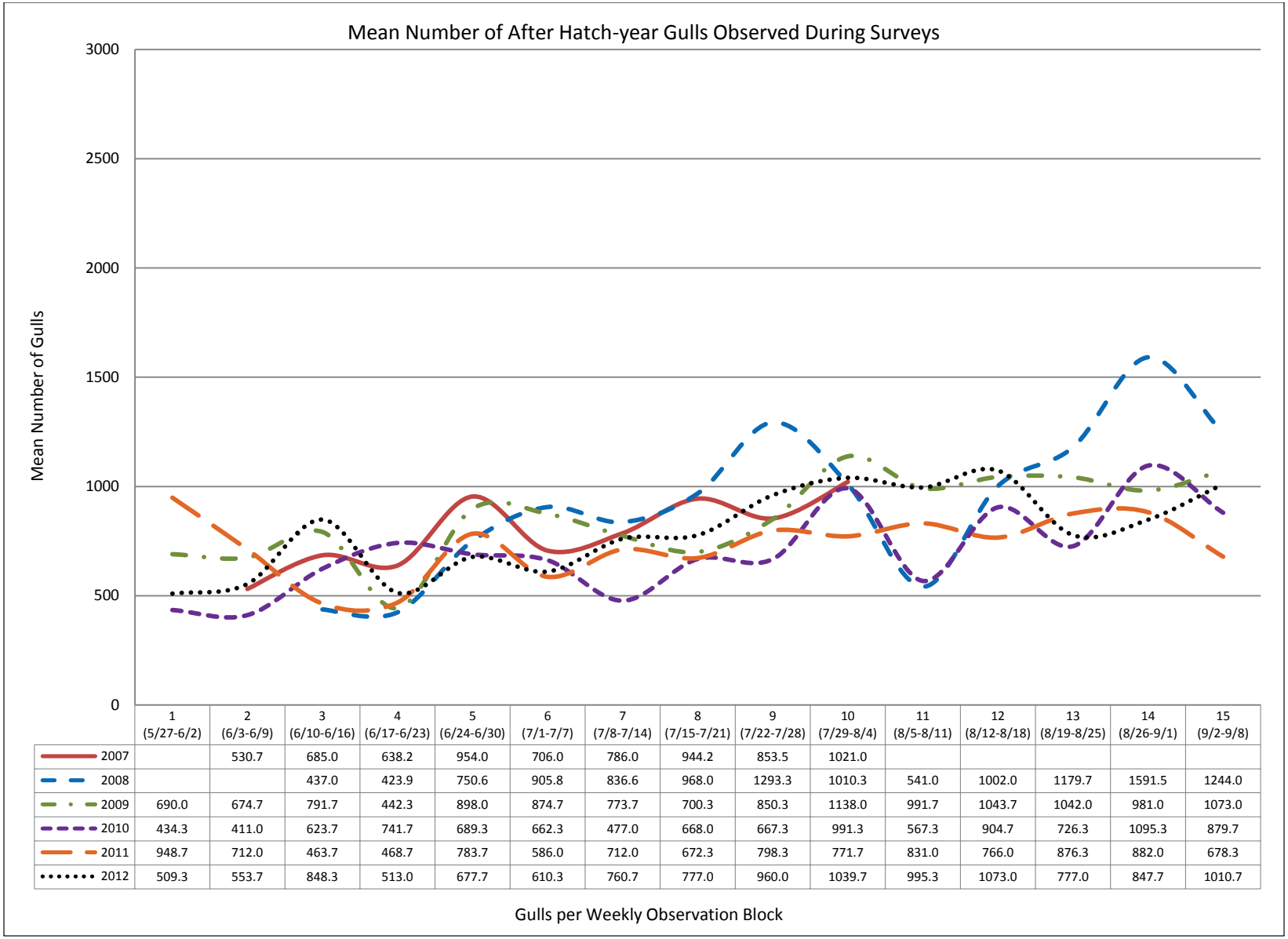
Figure 3. Total number of nests and eggs removed or treated in Chicago between 2007 and 2012.



	1 (5/27-6/2)	2 (6/3-6/9)	3 (6/10-6/16)	4 (6/17-6/23)	5 (6/24-6/30)	6 (7/1-7/7)	7 (7/8-7/14)	8 (7/15-7/21)	9 (7/22-7/28)	10 (7/29-8/4)	11 (8/5-8/11)	12 (8/12-8/18)	13 (8/19-8/25)	14 (8/26-9/1)	15 (9/2-9/8)
2007		0.0	0.0	0.0	21.7	198.5	895.0	1028.7	881.0	1034.0					
2008			0.0	0.0	14.1	113.6	213.2	279.0	240.0	180.0	88.3	128.0	157.7	189.5	167.0
2009	0.0	0.0	0.0	5.0	6.0	74.3	108.3	111.7	139.3	155.0	252.0	208.7	185.7	122.7	98.3
2010	0.0	0.0	0.0	0.3	28.7	75.7	191.3	162.0	139.0	159.7	97.7	165.7	85.0	130.3	81.0
2011	0.0	0.0	0.0	0.7	1.3	18.0	49.7	95.7	93.0	108.0	75.7	39.7	81.7	66.3	78.3
2012	0.0	0.0	0.0	0.0	1.7	12.3	20.0	45.7	74.7	69.7	71.0	38.3	45.3	36.7	43.0

Note observations were not conducted for the entire swim season in 2007 and 2008.

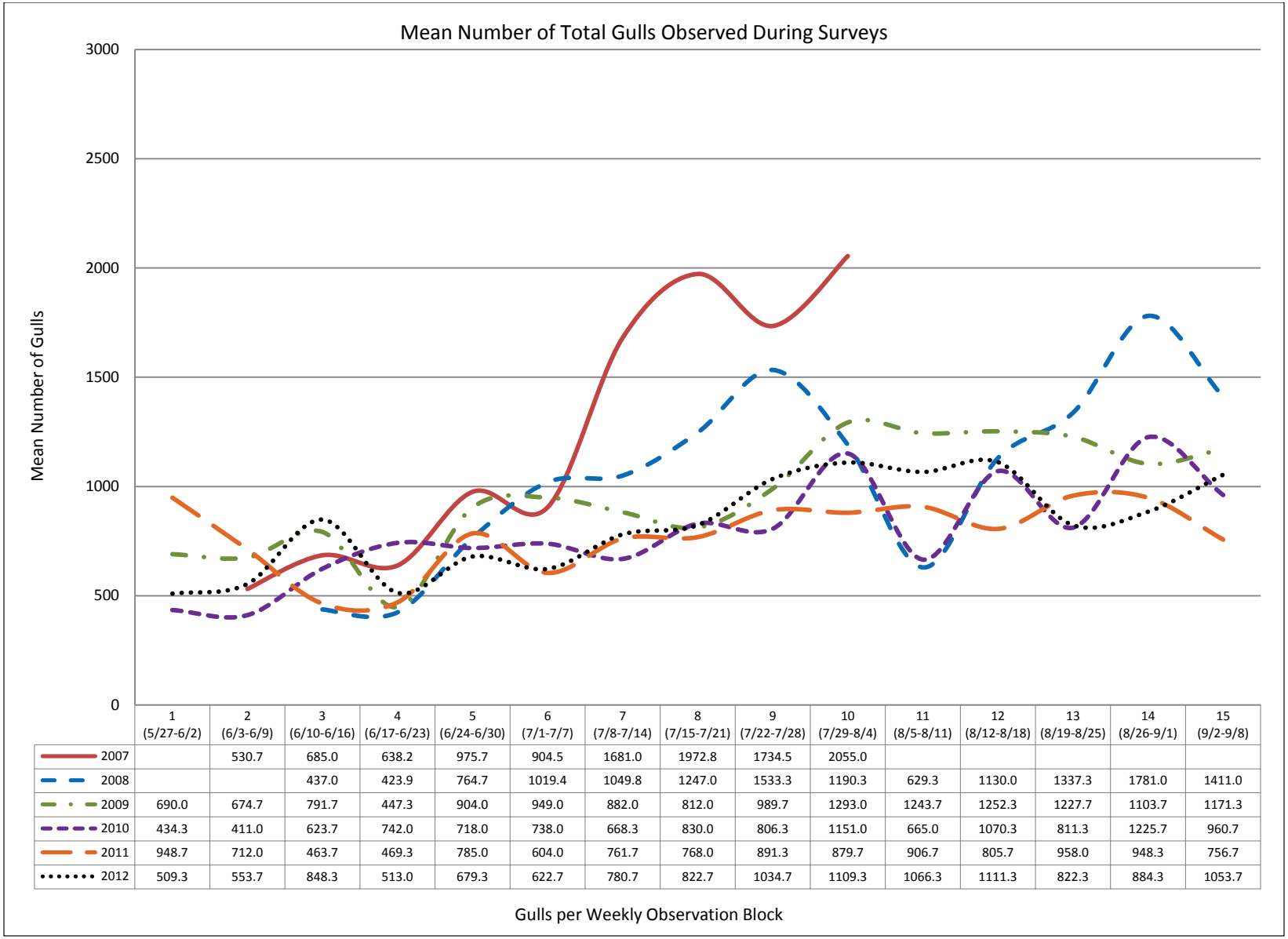
Figure 4. Mean number of hatch-year ring-billed gulls observed at nine Chicago beaches per weekly observation block during 2007-2012.



	1 (5/27-6/2)	2 (6/3-6/9)	3 (6/10-6/16)	4 (6/17-6/23)	5 (6/24-6/30)	6 (7/1-7/7)	7 (7/8-7/14)	8 (7/15-7/21)	9 (7/22-7/28)	10 (7/29-8/4)	11 (8/5-8/11)	12 (8/12-8/18)	13 (8/19-8/25)	14 (8/26-9/1)	15 (9/2-9/8)
2007		530.7	685.0	638.2	954.0	706.0	786.0	944.2	853.5	1021.0					
2008			437.0	423.9	750.6	905.8	836.6	968.0	1293.3	1010.3	541.0	1002.0	1179.7	1591.5	1244.0
2009	690.0	674.7	791.7	442.3	898.0	874.7	773.7	700.3	850.3	1138.0	991.7	1043.7	1042.0	981.0	1073.0
2010	434.3	411.0	623.7	741.7	689.3	662.3	477.0	668.0	667.3	991.3	567.3	904.7	726.3	1095.3	879.7
2011	948.7	712.0	463.7	468.7	783.7	586.0	712.0	672.3	798.3	771.7	831.0	766.0	876.3	882.0	678.3
2012	509.3	553.7	848.3	513.0	677.7	610.3	760.7	777.0	960.0	1039.7	995.3	1073.0	777.0	847.7	1010.7

Note observations were not conducted for the entire swim season in 2007 and 2008.

Figure 5. Mean number of after hatch-year ring-billed gulls observed at nine Chicago beaches per weekly observation block during 2007-2012.



	1 (5/27-6/2)	2 (6/3-6/9)	3 (6/10-6/16)	4 (6/17-6/23)	5 (6/24-6/30)	6 (7/1-7/7)	7 (7/8-7/14)	8 (7/15-7/21)	9 (7/22-7/28)	10 (7/29-8/4)	11 (8/5-8/11)	12 (8/12-8/18)	13 (8/19-8/25)	14 (8/26-9/1)	15 (9/2-9/8)
2007		530.7	685.0	638.2	975.7	904.5	1681.0	1972.8	1734.5	2055.0					
2008			437.0	423.9	764.7	1019.4	1049.8	1247.0	1533.3	1190.3	629.3	1130.0	1337.3	1781.0	1411.0
2009	690.0	674.7	791.7	447.3	904.0	949.0	882.0	812.0	989.7	1293.0	1243.7	1252.3	1227.7	1103.7	1171.3
2010	434.3	411.0	623.7	742.0	718.0	738.0	668.3	830.0	806.3	1151.0	665.0	1070.3	811.3	1225.7	960.7
2011	948.7	712.0	463.7	469.3	785.0	604.0	761.7	768.0	891.3	879.7	906.7	805.7	958.0	948.3	756.7
2012	509.3	553.7	848.3	513.0	679.3	622.7	780.7	822.7	1034.7	1109.3	1066.3	1111.3	822.3	884.3	1053.7

Note observations were not conducted for the entire swim season in 2007 and 2008.

Figure 6. Mean number of total ring-billed gulls observed at nine Chicago beaches per weekly observation block during 2007-2012.