NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF WATER SUPPLY

Waterfowl Management Program

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Prepared in accordance with Section 4.1 of the NYSDOH Revised 2007 Filtration Avoidance Determination

A Waterfowl Management Program was developed to evaluate and mitigate pollutant impacts (fecal coliform bacteria) from migratory and resident waterbirds (waterfowl, gulls and cormorants). The purpose of the study reported here, for the period April 1, 2014 to July 31, 2015, is to evaluate further the trends observed in bird numbers and their effect on fecal coliform bacteria levels as a consequence of DEP's Waterfowl Management Program.

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INTRODUCTION

The management of waterbird populations at key reservoirs throughout the New York City Water Supply is essential to meet stringent water quality regulations as stated in the Environmental Protection Agency's (USEPA) Surface Water Treatment Rule (SWTR) (USEPA 1989). As a result, New York City Department of Environmental Protection (DEP) developed and implemented a comprehensive Watershed Protection Program to protect its water supply and as a requirement of Filtration Avoidance Determinations received from USEPA and New York State Department of Health (NYSDOH). A component of the Watershed Protection Plan is DEP's Waterfowl Management Program (WMP) which was established to research and manage the relationship between wildlife, particularly waterbirds (geese, gulls, cormorants, swans, ducks, and other duck-like birds) that inhabit the reservoirs and fecal coliform bacteria elevations in the untreated and treated surface water. The Waterfowl Management Program, originally developed for NYC's Kensico Reservoir in 1992, was expanded to include five additional reservoirs for waterbird management under the November 2002 Filtration Avoidance Determination (FAD) (Section 4.1 – Waterfowl Management Program). The 2007 FAD (USEPA 2007) further expanded program to include bird management at Hillview Reservoir in Yonkers, New York. A Revised 2007 FAD was issued in May 2014 (NYSDOH 2014).

The WMP was designed to study the relationship between seasonal trends in bird populations on the reservoirs as well as trends in fecal coliform concentrations both within the reservoir and at the keypoint water sampling locations. Following several years of waterbird population monitoring, DEP's scientific staff consisting of wildlife biologists and microbiologists identified birds as a significant source of fecal coliform at the Kensico Reservoir (DEP 1993). In response, DEP developed and implemented a Waterfowl Management Program using standard bird management techniques (approved by the United States Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services (USDA) and the New York State Department of Environmental Conservation (NYSDEC) to reduce or eliminate the waterbird populations inhabiting the reservoir system (DEP 2002). DEP has also acquired depredation permits from the United States Fish & Wildlife Service (USFWS) and NYSDEC to implement some wildlife management techniques. Since the initial implementation of DEP's bird dispersal and deterrent techniques in 1993 there has been a significant reduction in both bird populations and fecal coliform levels, thus maintaining high quality water in compliance with the SWTR.

Migratory populations of waterbirds utilize NYC reservoirs as temporary staging areas and wintering grounds and therefore can significantly contribute to increases in fecal coliform loadings in the reservoirs during the autumn and winter, primarily from direct fecal deposition. These migrant waterbirds generally roost nocturnally and occasionally forage and loaf diurnally on the reservoirs, however, it has been determined that most of the feeding activity occurs away

from the reservoir. Fecal samples collected and analyzed for fecal coliform bacteria concentrations from both Canada Geese (*Branta canadensis*) and Ring-billed Gulls (*Larus delawarensis*) revealed that fecal coliform concentrations are high per gram of feces (Alderisio and DeLuca 1999). Water samples collected near waterbird roosting locations have shown fecal coliform increases concurrent with waterbird populations at several NYC reservoirs in previous DEP reports (DEP 1993 - 2014). Since waterbirds have been associated with elevated fecal coliform bacteria levels found in various reservoirs and lakes (Gould and Fletcher 1978, Hussong et al 1979, Standridge et al 1979, Benton, et al 1983, DEP 1992 and 1993, Levesque et al 1993), a program to discourage waterbird activity was developed for Kensico Reservoir in the autumn of 1993 and is expected to continue indefinitely. The bird dispersal program was expanded in 2004 to allow for "as-needed" waterbird management at five additional reservoirs (Rondout, West Branch, Ashokan, Croton Falls, and Cross River). Since that time, the "as-needed" program has been implemented a total of six times with actions at Rondout Reservoir during the winters of 2002/2003, 2003/2004 and 2005/2006, West Branch Reservoir in 2007 and 2010/2011, and at Croton Falls Reservoir during the winter of 2001/2002. To assure DEP's program activities remained in compliance with all federal, state, and local laws including effects on local communities and environmental conditions including endangered species, an Environmental Impact Statement was completed for Kensico in 1996 and second one in the spring of 2004 for the five additional "as-needed" reservoirs. A Final Environmental Impact Statement including a "findings statement" can be found on the DEP website identifying program impacts and required mitigation to meeting implementation standards for the expanded WMP (DEP 2004). This report is a requirement of the current Revised 2007 FAD.

The purpose of this report is to evaluate further the down-trend observed in waterbird populations and its impact on fecal coliform bacteria concentrations as a consequence of DEP's Waterfowl Management Program for the period April 1, 2014 through July 31, 2015. In compliance with a request from USEPA and NYSDOH following the submission of the 2014 FAD Annual Report, DEP has adjusted the end date of the reporting period for this report from March 31, 2015 to July 31, 2015.

METHODS

Waterfowl Management Program

The Waterfowl Management Program was initiated in 1993 by the City for the Kensico Reservoir in response to elevated fecal coliform bacteria levels contained in the Reservoir. DEP determined that the water leaving Kensico reported higher levels of bacteria than the water entering Kensico from source reservoirs and as a result focused on identifying and mitigating local inputs of bacterial pollution (DEP 1992). Preliminary waterbird surveys conducted by DEP staff in 1992 demonstrated a seasonality effect with increased numbers of roosting birds and elevated fecal coliform bacteria levels. By December 1993, DEP started a daily bird dispersal program that evolved into a tri-season effort from August through March annually. The program was subsequently expanded to include additional reservoirs.

The 2002 FAD required that the City continue this program for the Kensico Reservoir on an annual basis and expand the program to an "as-needed" basis for five additional reservoirs. Three of these five reservoirs (West Branch, Rondout, and Ashokan) routinely supply Kensico with its source water (Figures 64 and 65). The remaining two (Cross River and Croton Falls), while in the Croton System (Figure 64), may also provide Kensico with source water under certain conditions and with permission from the New York State Department of Health. The objective of the program is to minimize the fecal coliform loading to the reservoirs that result from roosting birds during the migratory season. The program includes three activities: avian population monitoring, avian dispersal activities (motorboats, airboats, propane cannons, physical chasing, remote control motorboats, and pyrotechnics) and avian deterrence (depredation of nests and eggs, bird exclusion wires, and netting at critical intake chambers). All avian dispersal techniques and deterrence activities have been approved by USDA and NYSDEC.

The City's 2006 Long-Term Watershed Protection Program expanded the Waterfowl Management Program to include "as-needed" avian dispersal activities for the Hillview Reservoir as well as avian deterrent measures for Hillview and other City reservoirs.
The term "as-needed" refers to implementation of avian management measures based on the following criteria:

- fecal coliform bacteria concentrations approaching or exceeding 20 colony-forming units per 100 milliliters at reservoir effluent structures coincident with elevated bird populations;
- current bird populations, including roosting or staging locations relative to water intakes;
- recent weather events;
- operational flow conditions within the reservoir (i.e. elevations and flow patterns and amounts);
- reservoir ice coverage and watershed snow cover; and

- an assessment that active bird management measures would be effective in reducing bird populations and fecal coliform bacteria levels.

The Revised 2007 FAD requirements for the Waterfowl Management Program are outlined in Table 1, below.

Table 1. Revised 2007 FAD Activity and Reporting Requirements (NYSDOH 2014)

Requirements	Due Date
Active Bird Harassment – Kensico Reservoir	Annually, 8/1 to 3/31
Active Bird Harassment – Hillview Reservoir	Year-around
"As-needed" bird harassment – West Branch, Rondout, Ashokan, Croton Falls, and Cross River Reservoirs.	Annually, 8/1 to 4/15
"As-needed" bird deterrent measures – Kensico, West Branch, Rondout, Ashokan, Croton Falls, Cross River, and Hillview Reservoirs.	Year-round
Report Description	**Due Date**
Summary of Waterfowl Management Program activities for all reservoirs, including contract status.	Annually, 9/30

Waterfowl Management Program Contract Status

The Waterfowl Management Program (WMP-12 Renewal) contract that covered this reporting period expired on July 31, 2015. The new Waterfowl Management Program Contract (WMP-16) is a three year contract for services that will be provided by Henningson, Durham, and Richardson, P.C. (HDR) of Mahwah, New Jersey for the term of August 1, 2015 through July 30, 2018 with an option to renew through July 31, 2020.

Waterbird Census

The relationship between elevated waterbird counts and increased levels of fecal coliform bacteria identified from raw water samples is well established. New York City reservoirs, situated in southeastern New York State, lie in the Atlantic Flyway; an important migratory pathway for many groups of birds including waterbirds. The NYC reservoirs may offer important areas of open fresh water used for night roosting, foraging, winter stop-overs, and breeding habitat for some waterbirds species. Since it has been well documented that the primary bacterial contribution to the water supply is from night-roosting and migratory birds

defecating in the reservoirs, night census data is presented throughout this report. Defecation rates of waterbirds are typically lower nocturnally than diurnally due to reduced foraging and physical activity, however overnight roosting involves longer periods of time during which the birds habituate on the reservoirs (DEP 1993).

Daily waterbird observations were conducted at predawn hours (between 4:30am and 8:00am E.S.T.) and post dusk hours (between 5:00pm and 10:00pm E.S.T.) to determine overnight waterbird roosting populations and to evaluate the success of the dispersal activities from the previous day (where applicable) at all reservoirs. Survey times vary seasonally reflecting available daylight hours. For successful bird observation data collection, ideal weather and atmospheric conditions were necessary. Precipitation events and fog prohibited data collection and resulted in short gaps of "no data". Reservoir maps with bird zones can be found in Appendix A.

The Revised 2007 FAD, Section 4.1 specifies the frequency of reservoir surveys and is listed in Table 2. In May 2013 NYSDOH approved DEP's request to reduce bird surveys for West Branch, Rondout, Ashokan, Croton Falls, and Cross River Reservoirs. To fulfill the NYSDOH request that DEP continue to monitor populations of birds that are roosting or staging in close proximity to reservoir intakes, DEP performed diurnal bird population observations at Rondout, Ashokan, and West Branch Reservoir effluent chambers during routine site visits by Aqueduct Monitoring staff in the form of un-aided (i.e., without binoculars) observations on a weekly basis. Proposed and actual contractor surveys conducted from April 1, 2014 to July 31, 2015 are also listed in Table 2.

Table 2. Frequency of bird observation surveys by reservoir 2014/2015 (as listed under the November 2002 FAD, Section 4.1).

Reservoir	Bird Surveys Scheduled	Proposed/Actual Surveys
Kensico	Pre-dawn to post-dusk daily August 1 to March 31; Pre-dawn and post-dusk weekly April 1 to July 31	279/273[1,2]
West Branch	Pre-dawn, midday, and post-dusk, biweekly; August 1 to April 15 annually	20/20
Hillview	Pre-dawn, midday, and post-dusk daily all year	487/486[3]

[1] A total of three surveys were cancelled due to holiday observances.
[2] A total of three surveys were cancelled due to severe winter storms on 1/24/15, 1/27/15, and 2/2/15.
[3] One survey was cancelled due to a severe winter storm on 1/27/15.

Reservoir-wide observational surveys for waterbirds were conducted year-round at Kensico and Hillview Reservoirs (Table 2). As-needed waterfowl management actions including

surveys will only be conducted annually at Rondout, Ashokan, Croton Falls, and Cross River and at West Branch from August 1 to April 15 annually. DEP's request was approved by NYSDOH on March 13, 2013, and West Branch surveys went from weekly to biweekly from August 1 through April 15 annually and on an "as-needed" basis for the remainder of the year, and surveys were modified to "as-needed" for Rondout, Ashokan, Croton Falls, and Cross River Reservoirs.

Each survey recorded species evenness (number per species), species richness (species diversity), roosting and foraging locations, flight patterns into and out of the reservoir, bird band/collar identifications, and general behavior during the overnight roosting period. Waterbird data were collected from shoreline locations and/or watercraft (motorboat, Jon boat, or airboat) by a wildlife biologist, ornithologist, or wildlife technician using binoculars and spotting scopes. DEP developed field data sheets to record observation locations with times for each reservoir. Data are entered in an Excel spreadsheet and is checked twice for Quality Assurance/Quality Control.

Each survey data point can consist of a minimum of one or two site visits per datum reported (i.e. night before and morning after the nightly roost), and is dependent on the field conditions (i.e. weather, fog), reservoir physical characteristics (i.e. drought, ice cover), and time of year (leaf-cover or not). Data collected during reservoir-wide surveys that were incomplete due to inclement weather were not reported. Only high counts for each category of waterbirds were used for data recording. For example, if there was a count of 20 Canada Geese at a bird observation location and zero for the rest of the reservoir for the night before count and a count of 20 ducks at another location on the morning after survey, a combination of 20 geese and 20 ducks would give a reservoir-wide total of 40 birds. The purpose of using two surveys for data collection is ascertaining species highest concentrations over a specific time period. Some species at certain times of the year are easier to count in the evening when birds are flying into roost areas (or open water) whereas other species are easier to count when flying out of the reservoir in the early morning.

Waterbird population zones were delineated at all reservoirs to identify local impacts on water quality and have been described in previous DEP reports for Kensico and West Branch (DEP 1994, 1995, 1997a).

Fecal Coliform Bacteria Data

Data reported on fecal coliform bacteria concentrations for both keypoint raw water outflow samples (aqueduct and outflows) and reservoir samples have been reviewed by DEP laboratory and field personnel. The following conditions apply to the water quality data reported:

- Only high concentration duplicate samples are reported (for example if two keypoint samples were collected in a single day, or if more than one sample is collected at

different depths at a single limnology sampling location, the highest bacteria count has been used for charting)

- All special investigation samples are reported
- Reanalysis samples are reported
- There were no samples with confluent growth reported

Water quality data presented in this report were collected by DEP's Watershed Water Quality Operations and Distribution Water Quality Operations personnel and analyzed and reported by four DEP New York State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP) certified DEP laboratories in Valhalla, Kingston, Grahamsville, and Queens, New York. Watershed DEP laboratory personnel utilized the Membrane Filtration Technique for fecal coliform analyses. DEP's Distribution Laboratory personnel utilized the Colilert18 with Quantitray for *E.coli* analyses for samples collected at Hillview Reservoir. Reservoir-wide waterbird survey results are presented with fecal coliform bacteria levels at keypoint (outflow) and reservoir sampling areas.

Precipitation Data

Precipitation data used in this report for the Kensico Reservoir was provided by DEP's Bureau of Water Supply Operations Directorate staff and were recorded at the Westchester County Airport meteorological station, located in White Plains, New York.

Waterbird Dispersal and Deterrent Techniques

The list of bird dispersal activities conducted since 2002 is presented in Table 3. Waterbird dispersal techniques were employed at Kensico Reservoir from August 1, 2014 through March 31, 2015 using motorboats, airboats, Jon boats, and noisemakers (pyrotechnics include bird bangers, screamers, and CAPA's). At Hillview Reservoir, pyrotechnics, physical chasing, propane cannons, and remote-control motorboats were used as deemed necessary on a daily basis year-around during this reporting period. Dispersal techniques were conducted under a DEP Waterfowl Management Program contract (WMP-12 Renewal) and by DEP staff. Beginning at 8:00am and continuing until approximately 1.5 hours past sunset, bird dispersal activities were conducted reservoir-wide, targeting all species except those with a federal or NYS endangered or threatened status such as N.Y.S. threatened Pied-billed Grebe (*Podilymbus podiceps*), Bald Eagle (*Haliaeetus leucocephalus*), and N.Y.S endangered Peregrine Falcon (*Falco peregrinus*).

Airboats were available for bird dispersal in 2014/2015 at Kensico, capable of operating over ice and water interfaces with ease. The airboats also have heated cabins which provide longer time periods of bird dispersal operations during reservoir freezing periods throughout the winter. In addition, an Intergovernmental Cooperative Service Agreement contract has been continued with USDA to conduct lethal management of the resident duck population at Hillview Reservoir. Details of the contract work will be discussed in the Hillview Reservoir section of this report.

Table 3. Reservoir bird mitigation (April 1, 2014 - July 31, 2015).

Reservoir	Dates of Bird Dispersal and Deterrence	Bird Dispersal and Deterrence Measures Used
Kensico	August 1, 2014 – March 31, 2015	Bird dispersal (motorboats, airboats, Jon boats, and pyrotechnics), shoreline meadow management and fencing, Alewife collections, and maintenance of bird netting for terrestrial bird management (swallows, starlings, pigeons, etc.)
Hillview	April 1, 2014 - July 31, 2015	Bird deterrent overhead wire system, bird harassment (pyrotechnics, propane cannons, physical chasing, remote control motorboats), small mammal management, Alewife (baitfish) collections, maintenance of bird netting for terrestrial bird management (swallows, sparrows, etc.), bird deterrent wires on shaft buildings and on dividing wall railings, swallow and sparrow depredation, and lethal duck management

Some bird deterrent techniques such as bird netting on reservoir shaft buildings continue to be maintained throughout the upstate reservoirs. Ongoing maintenance of bird deterrent equipment at Hillview Reservoir continued to improve the success of diverting waterbirds and terrestrial avian species from inhabiting the surface water (Table 3). Such measures include an overhead bird deterrent wire system and dividing wall bird exclusion wire system at Hillview, bird netting covering effluent building intake openings, and removal of baitfish entering the

reservoir from aqueducts. The other five reservoirs included in this report are covered under the "as-needed" section for the expanded reservoirs.

In response to entrainment of Alewives (*Alosa pseudoharengus*) and other fish species into the water intake structures at Ashokan Reservoir and their subsequent outflow at Kensico Reservoir, DEP's Waterfowl Management contractor installed a temporary collection boom as deemed necessary around the Catskill Influent structure (CATIC) so that dead fish can be removed. Collection of Alewives is also conducted as-needed from the Hillview Reservoir dividing wall using landing nets to retrieve the dead floating fish. Alewives and other bait-sized fish are an attractive food source for avian piscivorous species such as gulls and some species of ducks such as the Common Merganser (*Mergus merganser*). Therefore, when large numbers of fish are flushing into the reservoir, removal of the fish helps to eliminate the attractiveness to the birds, making the birds very difficult to manage.

Waterbird Reproductive Management

Canada Geese and Mute Swan (*Cygnus olor*) egg and nest depredation techniques were conducted during the spring of 2014 and 2015 to help reduce fecundity at critical NYC reservoirs (Tables 4 and 5). Mallard (*Anas platyrhynchos*) nests at Hillview Reservoir were depredated under a federal USFWS depredation permit. Egg and nest-depredation involved locating all Canada Geese and Mute Swan nests within NYC reservoir property, numbering each nest and egg, and puncturing each egg with a probe to break the membrane thereby destroying the embryo. Eggs were then replaced in the nest to allow incubation to continue, but unsuccessfully without development. A small number of goose nests are often destroyed late in the breeding season to encourage the birds to relocate off reservoir property during the annual post-nuptial molt when the birds are rendered flightless for a few weeks.

A total of 39 Canada Geese nests containing 178 eggs were depredated (punctured) at six New York City Reservoirs (Table 5) during the spring of 2015 compared to 53 Canada Geese nests containing 262 eggs in 2014 (Table 4). There was no goose or swan breeding activity recorded at Hillview, however 2 Mallard nests containing 10 eggs were depredated in 2015 compared to 3 Mallard nests containing 23 eggs in 2014 by DEP. All Canada Geese depredation activity was conducted under the terms of Federal Registration (#RG-01040A) from the United States Department of the Interior, United States Fish & Wildlife Service. A NYSDEC permit (#3-14-46 and #3-15-96) was acquired for Mute Swans egg and nest depredation and a USFWS Permit (MB789947-0) covered Mallard depredation work at Hillview. DEP increased the number of Hillview Reservoir surveys for nesting Mallards from 153 in 2014 to 306 in 2015.

DEP did not conduct Canada Geese or Double-crested Cormorant banding in 2014 or 2015.

Table 4. 2014 Canada Geese, Mute Swan, and Mallard[2] nest census and egg-depredation.

Reservoir	Number of Surveys	Canada Geese/Mute Swan/[2]Mallard Nests	Canada Geese/Mute Swan/[2]Mallard Eggs Depredated	Canada Geese/Mute Swan/Mallard Depredation Success Rate
Kensico	10	20/1/NA	86/7/NA	98 percent (2 goslings)/100 percent (0 cygnets) /NA
West Branch	5	5/0/NA	26/0/NA	100 percent (0 goslings)/NA/NA
Rondout[1]	4	4/0/NA	28/0/NA	100 percent (0 goslings)/NA/NA
Ashokan	4	5/0/NA	29/0/NA	64 percent (16 goslings)/NA/NA
Croton Falls	7	10/1/NA	45/6/NA	100 percent (0 goslings) /100 percent (0 cygnets)/NA
Cross River	5	9/0/NA	48/0/NA	100 percent (0 goslings)/NA/NA
Hillview	153	0/0/3	0/0/23	NA/NA/79 percent (6 ducklings)

[1] Nest depredation for Canada Geese was restricted due to nesting Bald Eagles.
[2] Mallard nest depredation only conducted at Hillview Reservoir.

Table 5. 2015 Canada Geese, Mute Swan, and Mallard[2] nest census and egg-depredation.

Reservoir	Number of Surveys	Canada Geese/Mute Swan/[2]Mallard Nests	Canada Geese/Mute Swan/[2]Mallard Eggs Depredated	Canada Geese/Mute Swan/Mallard Depredation Success Rate
Kensico	6	16/1/NA	76/8/NA	100 percent (no goslings)/100 percent (0 cygnets) /NA
West Branch	4	3/0/NA	17/0/NA	100 percent (0 goslings)/NA/NA
Rondout[1]	3	4/0/NA	12/0/NA	100 percent (0 goslings)/NA/NA
Ashokan	3	3/0/NA	14/0/NA	70 percent (6 goslings)/NA/NA
Croton Falls	4	7/1/NA	37/6/NA	100 percent (0 goslings) /100 percent (0 cygnets)/NA
Cross River	5	6/0/NA	22/0/NA	85 percent (4 goslings)/NA/NA
Hillview	306	0/0/2	0/0/10	NA/NA/45 percent (12 ducklings)

[1] Nest depredation for Canada Geese was restricted due to nesting Bald Eagles.
[2] Mallard nest depredation only conducted at Hillview Reservoir.

RESULTS and DISCUSSION

1. Kensico Reservoir

Kensico Reservoir, a terminal reservoir in the New York City Water Supply System, receives water from Rondout and West Branch Reservoirs via the Delaware Aqueduct and from the Ashokan Reservoir via the Catskill Aqueduct (Figures 31 and 32). Water leaving Kensico is disinfected with chlorine and ultraviolet light prior to being delivered via aqueduct to Hillview Reservoir. Kensico Reservoir has been divided into eight Bird Zones to compare bird counts with water quality in samples collected at limnological sampling locations (Figure 33). Waterbird numbers at Kensico Reservoir remained consistently low throughout the reporting period as a result of continued implementation of the Waterfowl Management Program (Figure 1). The geographic configuration of Kensico includes two main open water areas; one in Bird Zone 4 and one in Bird Zone 6 (Figure 33). These open water areas tend to attract concentrations of gulls roosting overnight.

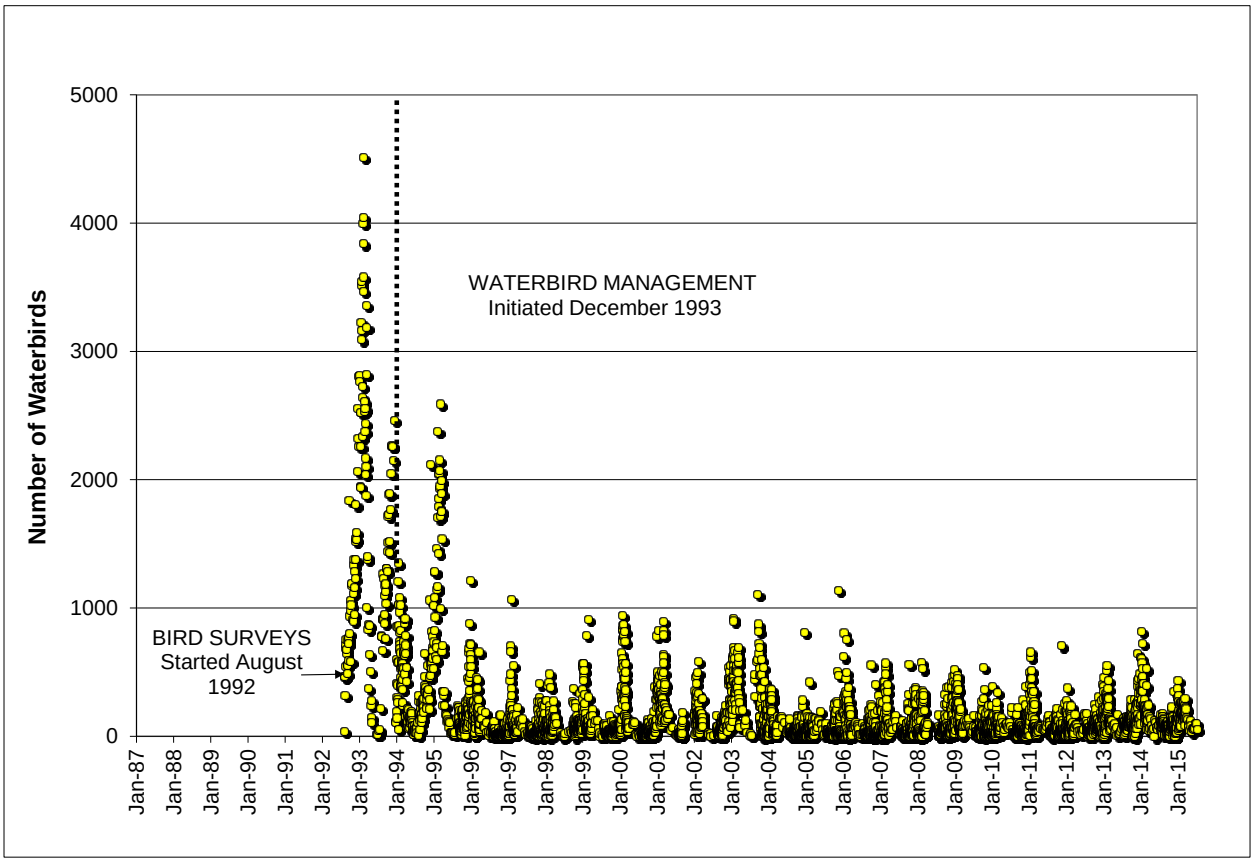


Figure 1. Kensico Reservoir waterbird totals.

Prior to implementing a formal bird dispersal program, DEP began collecting bird census data in August of 1992. Bird counts reached several thousand during the migratory/wintering period (Figure 1) with high bird roosting counts recorded at the water intake coves at Kensico. Figure 1 shows a dramatic decline in bird counts from several thousand in 1993 to a few hundred or less during the same migratory period in subsequent years with bird harassment techniques employed. Figure 2 shows a dramatic decline simultaneous with the commencement of the bird dispersal efforts in December 1993, and this observation (or effect) continues through the present day (Figure 2).

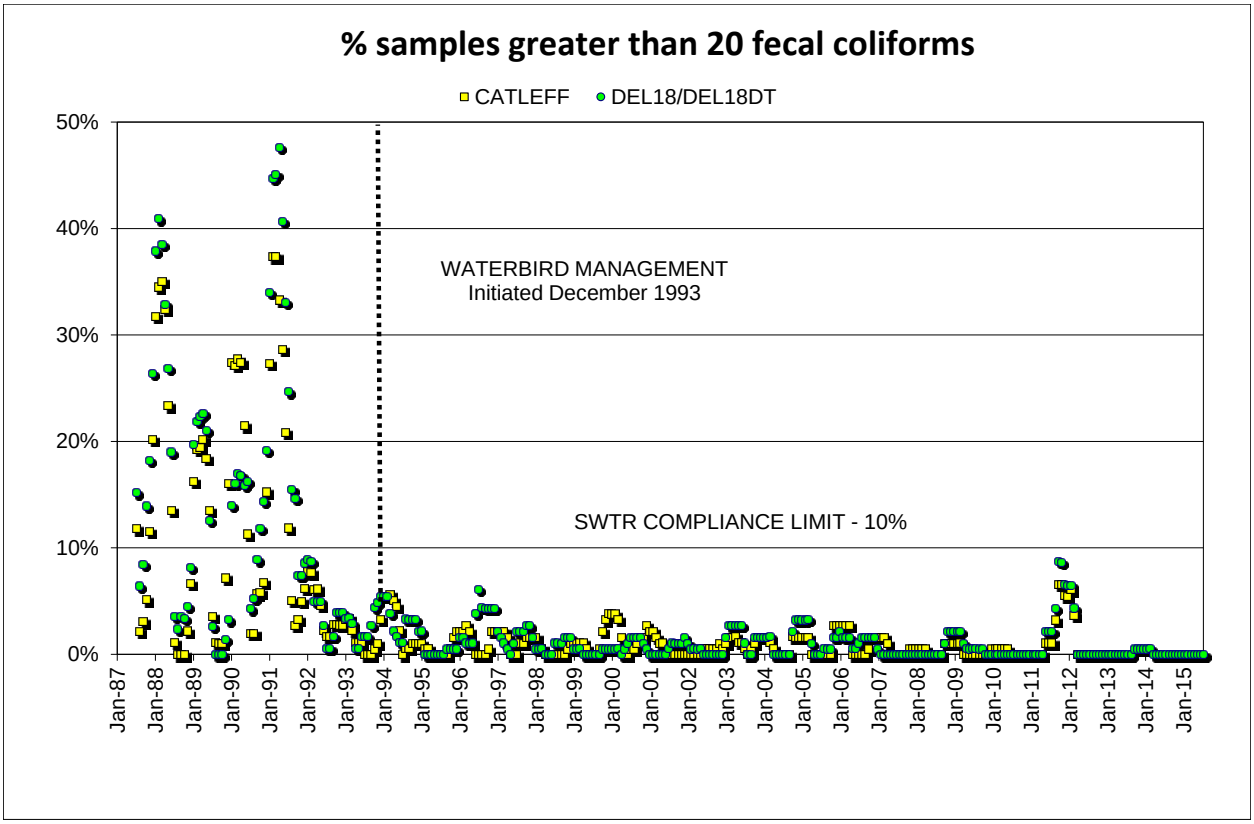


Figure 2. Kensico Reservoir Surface Water Treatment Rule compliance (fecal coliforms 100mL^{-1} at DEL18/DEL18DT and CATLEFF).

The WMP continued to maintain a high level of success from April 1, 2014 through July 31, 2015 managing waterbirds at Kensico Reservoir. Resident and migratory waterbird populations were kept at low levels (Figure 1); a result of implementing bird dispersal activities (Figure 3).

Figure 3. DEP contractor discharging pyrotechnics for bird dispersal activities at Kensico Reservoir. Photo by HDR, P.C.

Figures 4 and 5 compare the regulatory source water samples collected from Delaware Shaft 18 (DEL18DT and DEL18/DEL18DT) with respect to fecal coliform bacteria and reservoir bird counts for the 2014/2015 and 2013/2014 seasons.

In 2014 a coliform-restricted assessment based on compliance of the SWTR for Kensico Reservoir determined that the basin status was 'non-restricted', as was the case in 2012 and 2013 (DEP 2014). From April 1, 2014 through July 31, 2015 the percentage of source water sample results at DEL18DT above 20 fecal coliforms $100mL^{-1}$ over the previous six months remained at zero percent. During the current reporting period there was only one double digit fecal coliform count of '10' recorded on June 15, 2015. Table 6 lists the four highest fecal coliform counts (>=9) recorded in 2014/2015. Three of the four events were likely associated with precipitation events of more than one inch recorded in the previous three days (Table 6) and when bird counts remained relatively low in the bird zones closest to the water intake. The fecal coliform elevation recorded on June 15 was associated with 0.65 inches of rain. There were no waterbirds observed in Bird Zone 2 cove, closest to the DEL18DT sampling site on each of the three dates when 9 fecal coliforms 100 mL^{-1} was recorded. For comparison purposes, there was one sample

collected from DEL18DT that exceeded 20 fecal coliform 100mL^{-1} in the 2013/2014 reporting period (Figure 5).

Table 6. Highest fecal coliform 100mL^{-1} results (>=9), precipitation events, and bird counts at Kensico Reservoir keypoint water sampling location (DEL18DT).

Date	DEL18DT fecal coliform 100mL^{-1} (Bold indicates more than 20 fecal coliform 100mL^{-1})	Precipitation within 3 days of elevated fecal coliform >=9 fecal coliform 100 mL^{-1} (inches rounded to the nearest 100th)[1]	Bird Counts on or before sample date	
			Reservoir-wide totals	Bird Zones 2, 3, and 4 totals (closest to the DEL18DT Effluent)
7/5/14	9	2.45	60 on 7/2/14	48 on 7/2/14
7/15/14	9	3.18	86 on 7/9/14	72 on 7/9/14
12/10/14	9	2.60	355 on 12/10/14	32 on 12/10/14
6/15/15	10	0.65	66 on 6/10/15	15 on 6/10/15

[1] Precipitation data reported from Westchester County Airport, White Plains, New York

Reservoir-wide waterbird counts were slightly lower from December through February in this reporting period when compared to counts conducted during the same time period in 2013/2014. In 2014/2015 (April 1, 2014 to July 31, 2015) overnight waterbird counts averaged about 112 birds per survey night and spiked at 439 (155 geese, 222 gulls, and 62 ducks) on January 19, 2015 compared to an average of 172 birds/night in 2013/2014 (Figures 6 and 7).

In Bird Zone 2, closest to Delaware Shaft 18 (DEL18DT), waterbirds were observed 34 times in 2014/2015 of which 24 of those observations occurred during the bird harassment period and were largely attributed to extensive ice cover and flocks of ducks arriving overnight past the normal hours of operation for bird dispersal activities (Figure 8). All birds in the water intake cove (Bird Zone 2) observed during the pre-dawn period are immediately dispersed using motorboats. A high count of 23 waterbirds was observed in Bird Zone 2 on March 30, 2015 but was not associated with a fecal coliform bacteria elevation. Waterbird surveys in Bird Zone 3, adjacent to the Bird Zone 2 cove revealed only eight occasions when birds were present out of 276 survey days (Figure 9). A high count of 19 Canada Geese was recorded on April 23, 2014 and June 4, 2015 (Figure 9). Bird counts spiked at 171 waterbirds recorded on August 22, 2014 in Bird Zone 4 of which 160 were gulls (Figure 10). Waterbirds remained at zero in bird zone 4 for overnight counts from February 13, 2015 to March 10, 2015 similar to that reported for 2013/2014 and mostly in response to extensive reservoir icing.

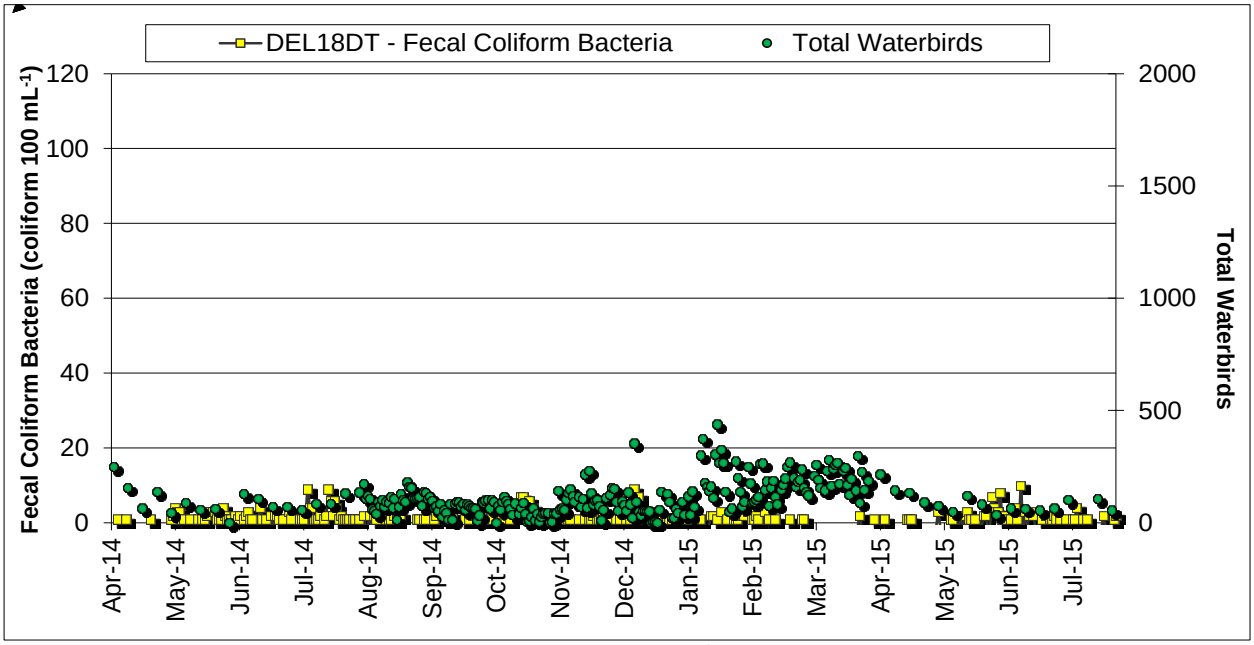


Figure 4. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18DT vs. total waterbirds (4/1/2014 to 7/31/2015).

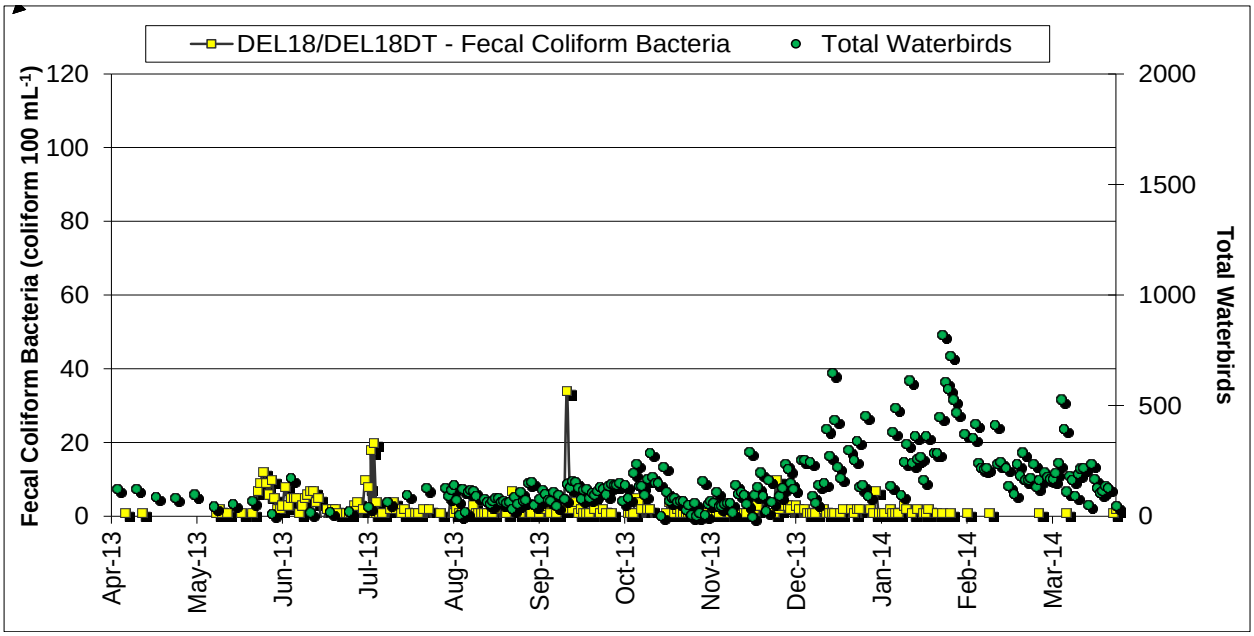


Figure 5. Kensico Reservoir fecal coliforms 100mL^{-1} at DEL18/DEL18DT vs. total

waterbirds (4/1/2013 to 3/31/2014).

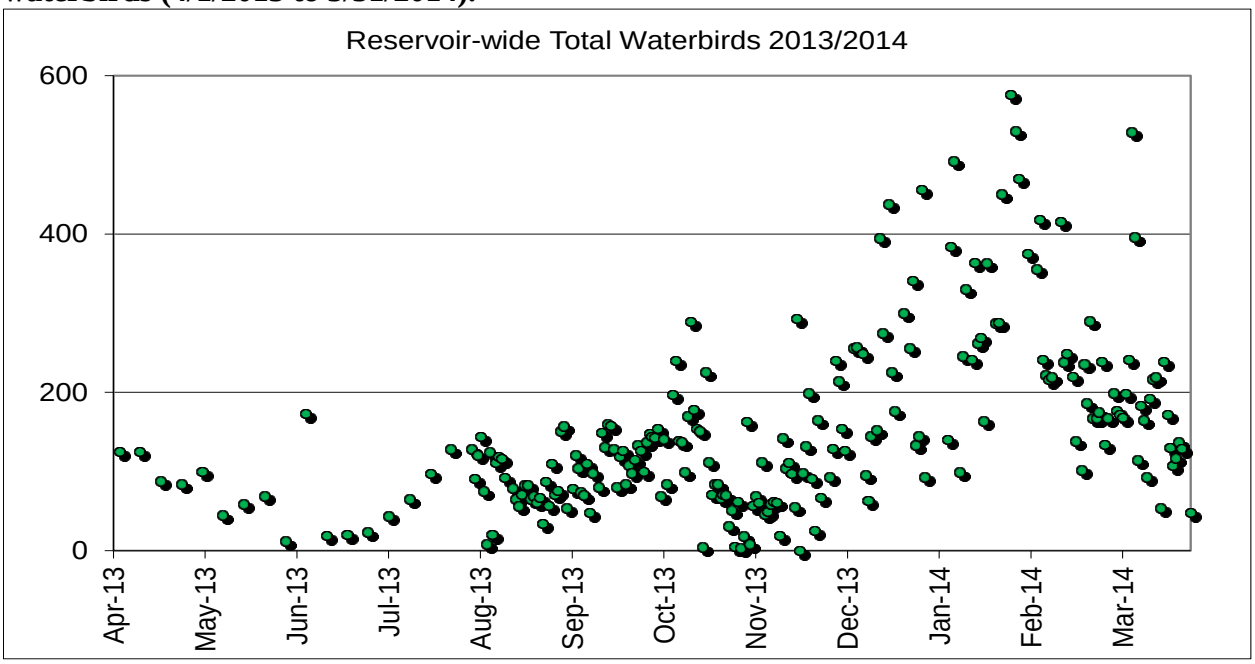


Figure 6. Kensico Reservoir total annual waterbirds (4/1/2013 to 3/31/2014).

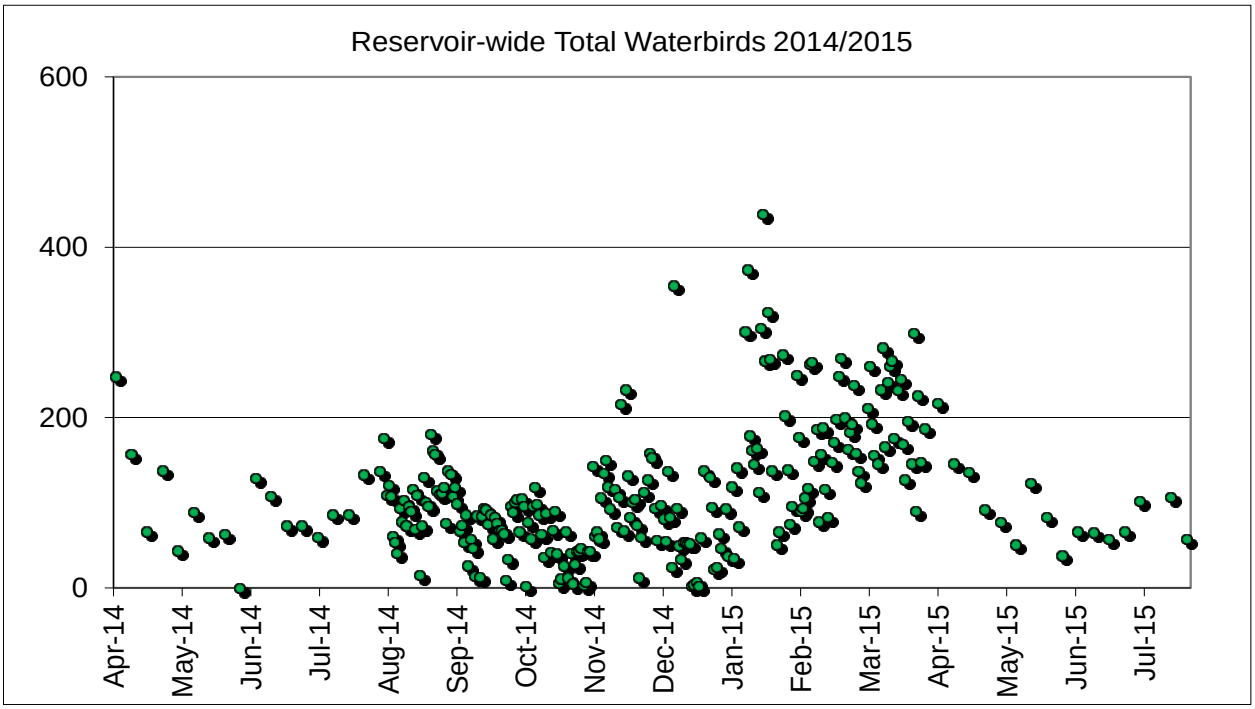


Figure 7. Kensico Reservoir total annual waterbirds (4/1/2014 to 7/31/2015).

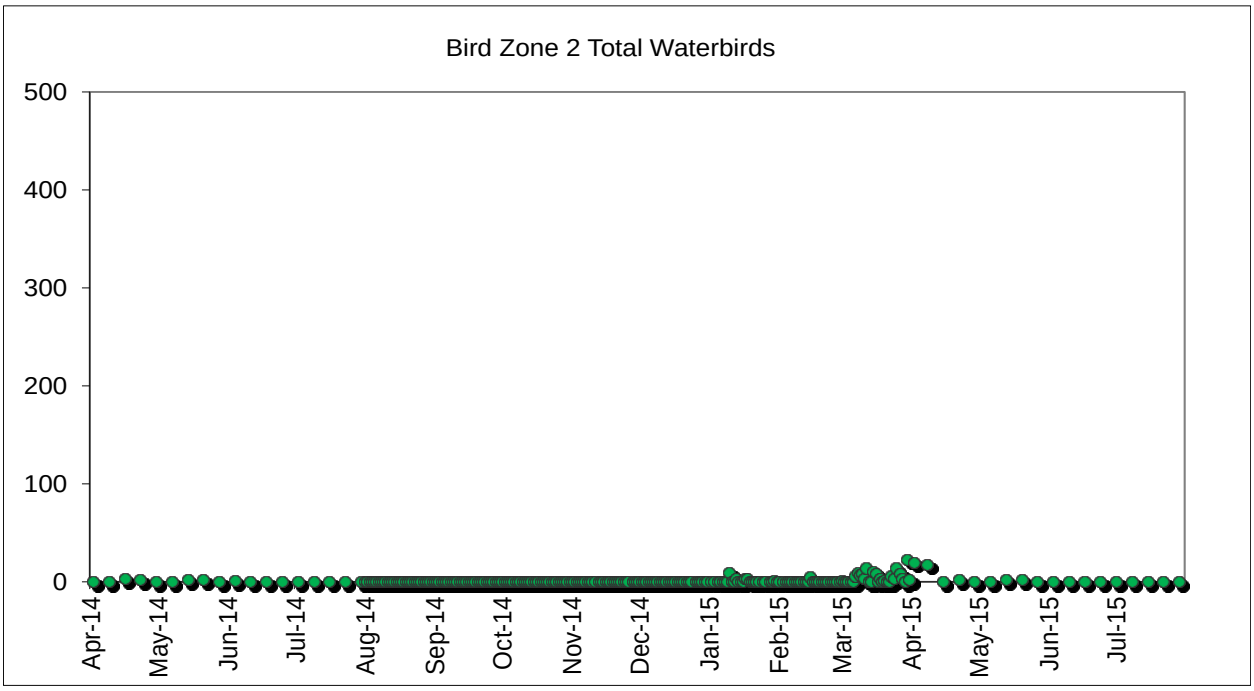


Figure 8. Kensico Reservoir Bird Zone 2 waterbirds (4/1/2014 to 7/31/2015).

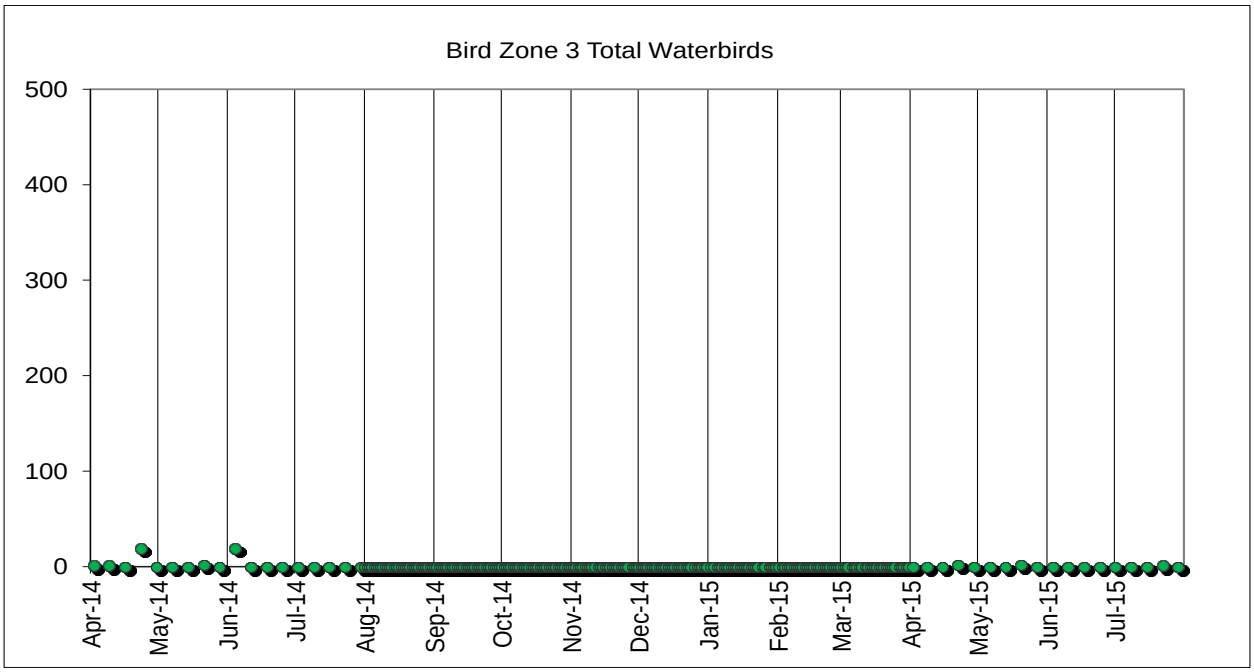


Figure 9. Kensico Reservoir Bird Zone 3 waterbirds (4/1/2014 to 7/31/2015).

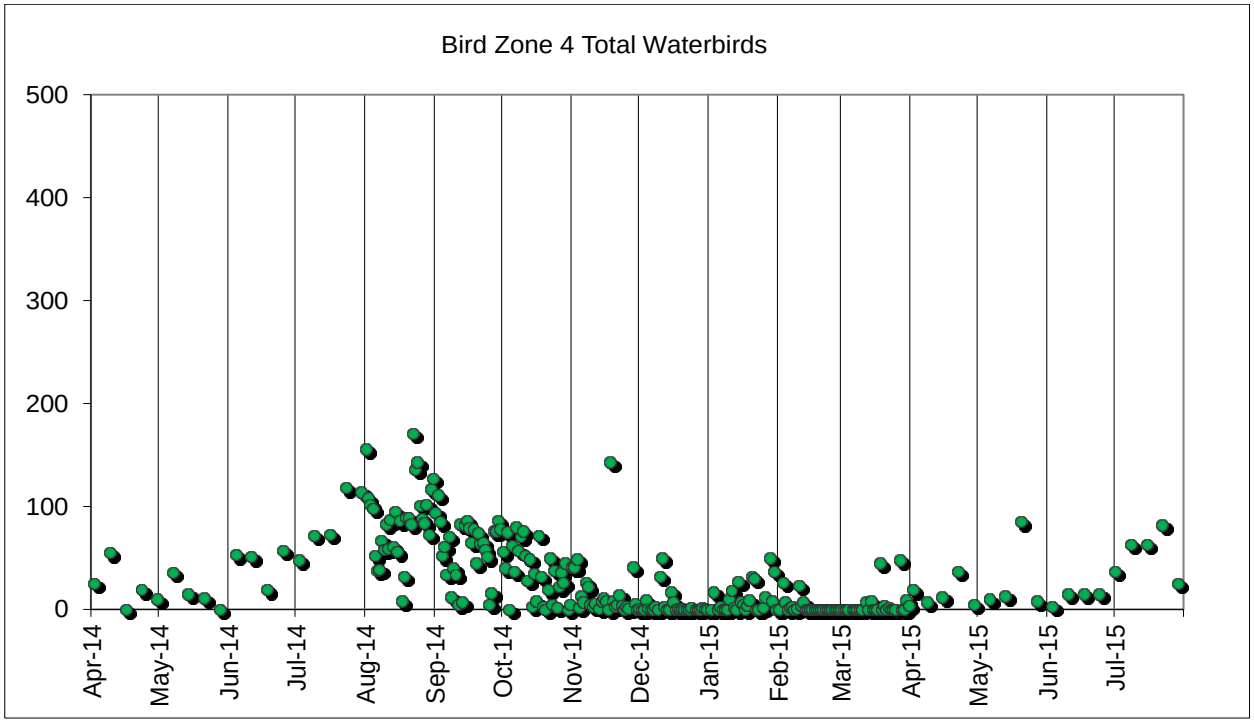


Figure 10. Kensico Reservoir Bird Zone 4 waterbirds (4/1/2014 to 7/31/2015).

The incidence of specific groups of waterbird groups continues to follow trends for annual migration and over-wintering patterns. Waterbird roosting locations during the winter period are generally determined by extent of ice-cover. During 2014/2015 the breakdown of waterbird groups was as follows: Canada Geese 18%, Gulls 28%, and Other Waterbirds (ducks, grebes, loons, swans and cormorants) 54%. Gull counts started rising at the end of July 2014 and declined by late-January 2015 extending through the end of March 2015 largely due to the extent of ice cover at Kensico. The DEP contractor used two Biondo Airboats for bird dispersal activities during the ice-cover period as the craft are designed to operate on ice or water interfaces (Figure 11). Kensico was approximately 99% covered by ice on February 15, 2015. Duck counts decreased from a daily average of 172 per overnight count in 2013/2014 (8/1/ to 3/31) to 62 per overnight count in 2014/2015 and Canada Geese numbers decreased from a daily overnight count of 24 in 2013/2014 compared to 21 in 2014/2015 and most likely represents the lack of open water due to freezing of other local and regional water bodies (Figures 12 and 13).

Figure 11. Pair of Biondo Airboats for bird dispersal activities at Kensico Reservoir. Photo by Chris Nadareski

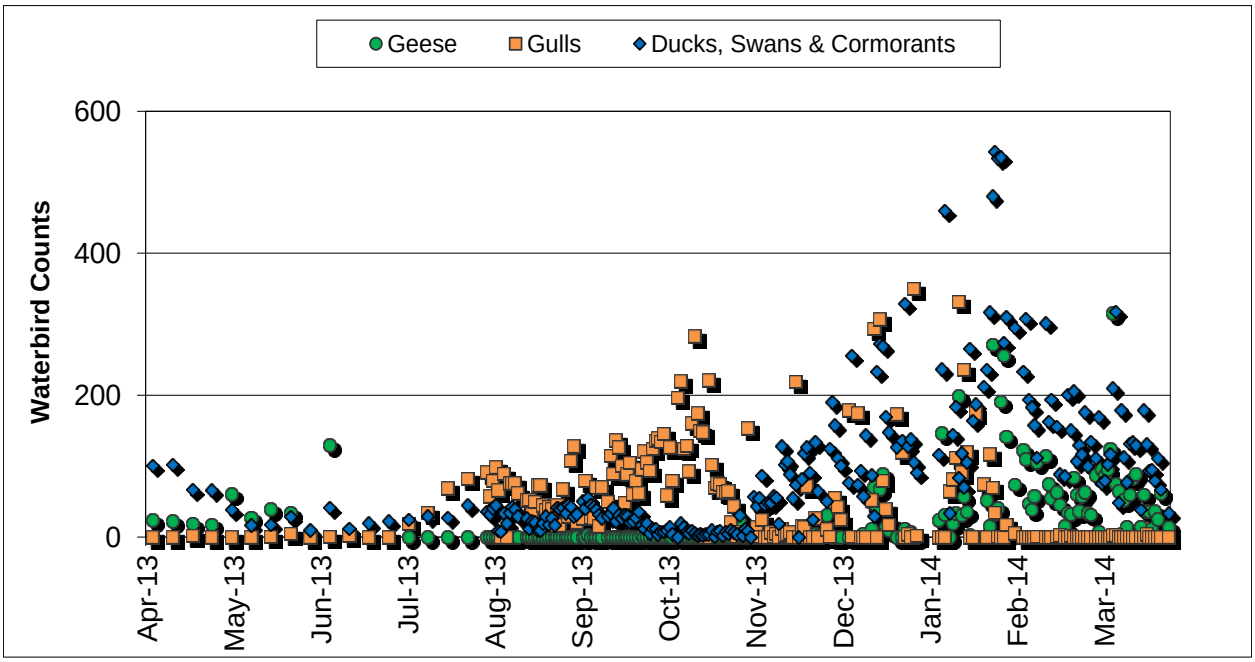


Figure 12. Kensico Reservoir total waterbirds by groups (4/1/2013 to 3/31/2014).

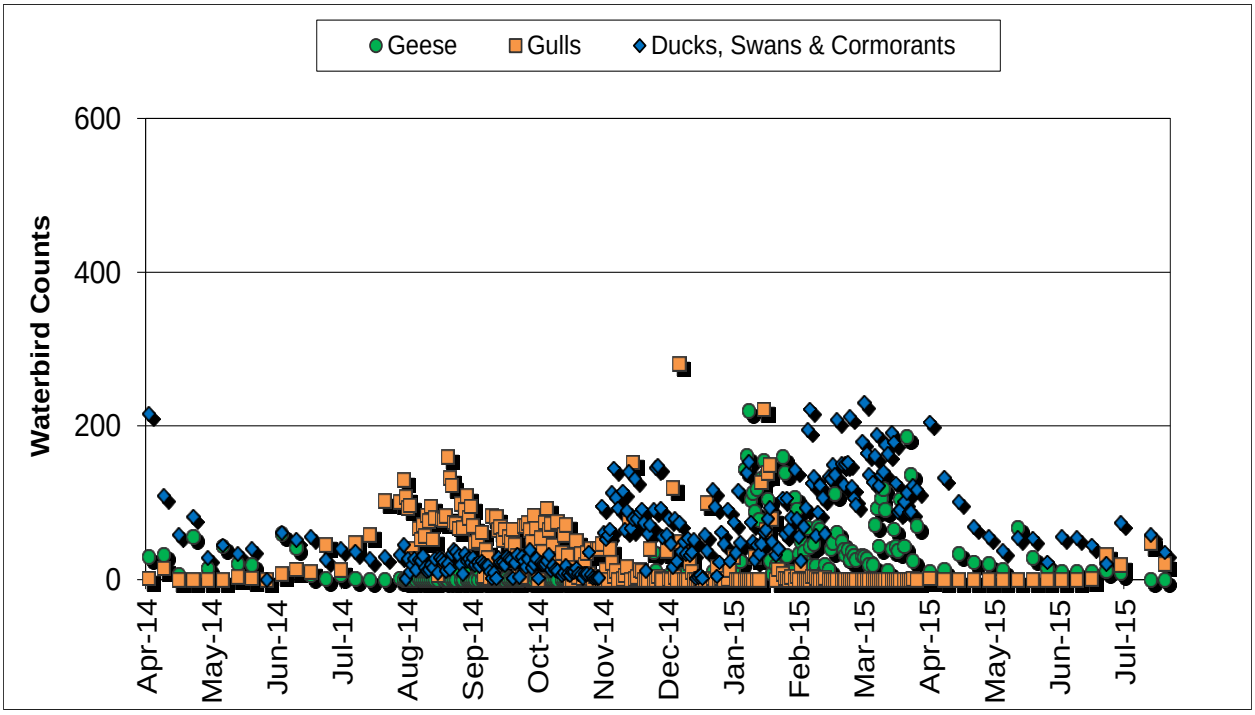


Figure 13. Kensico Reservoir total waterbirds by groups (4/1/2014 to 7/31/2015).

The Westchester County Airport, located immediately east of the Rye Lake area (Bird Zone 6 in Figure 33) continued to manage birds for air-traffic safety. As part of the airport's Wildlife Hazard Management Plan (Airport Depredation Orders – Resident Canada Goose nest and egg depredation order, 50 CFR 12.50 and Control order for resident Canada Geese at airports and military airfields 50 CFR 12.49), Westchester County has contracted with USDA to remove all Canada Geese within a seven-mile radius around the airport property which includes all of the Kensico Reservoir. During this reporting period, DEP allowed USDA officials under contract with the Westchester County Airport access to NYC-owned property to determine if there were geese present during the annual goose molt period in the spring of 2014 and 2015. Results of the USDA survey indicated that geese were present on the Kensico Reservoir property in both years. The USDA did not remove any Canada Geese in 2015 but did remove a total of three Canada Geese were live-trapped and removed from the reservoir property on June 18, 2014.

DEP's bird management activities have to prevent dispersal of waterbirds into the flight paths of arriving and departing aircraft at Westchester County Airport as the airport lies adjacent to the eastern shoreline of Kensico Reservoir (Figure 33). Bird dispersal crews are instructed to abstain from discharging pyrotechnics with approaching aircraft to avoid potential airstrikes with birds and pilot confusion with the use of aerial low-grade explosives. DEP maintains routine communication with airport officials including its contractor on any changes in bird management

activities conducted at the reservoir.

It is suspected that the increased spatial separation between birds and the water intake at Delaware Shaft 18 at Kensico is an important factor that helps reduce the threat of an increase in fecal coliform bacteria. As a result, bird dispersal activities were heavily concentrated in the vicinity Delaware of Shaft 18 and the lower main basin of Kensico (Bird Zones 2, 3, and 4; Figure 33). Overall, waterbird numbers continue to be sufficiently managed at Kensico to maintain compliance with the federal Surface Water Treatment Rule for fecal coliform bacteria levels.

Alewives and other baitfish transported through upstate aqueducts to Kensico were present during the autumn/winter period of 2014/2015. When present, the dead and dying Alewives typically attract foraging gulls and diving ducks. DEP and its contractor continued to monitor fish concentrations and collected dead/dying baitfish as they entered Kensico Reservoir. The volume of fish observed, collected, and disposed of at Kensico CATIC (influent) in 2014/2015 was 36.8 pounds compared to 41 pounds collected in 2013/2014 and 800.8 pounds collected in 2012/2013. The lower volume of fish observed in 2014/2015 reduced the amount of bird dispersal efforts necessary at the CATIC.

In the spring of 2015 a total of 16 Canada Geese nests were found along the reservoir shoreline and on islands compared to 20 in 2014. Among the nests, 76 eggs were depredated (punctured) and replaced back to the nest to allow the nesting geese to continue to incubate (Tables 4 and 5) compared to 86 eggs in 2014. The average number of eggs per nest in 2015 4.75 compared to 4.4 in the previous year. No goslings were observed in 2015 and 2 goslings were observed in 2014 rendering the egg depredation success at 100 percent in 2015 and at 98 percent in 2014. Adult breeding geese or failed breeders generally disperse from the reservoir prior to the post-breeding season molt which begins in June (annually) however if goslings are hatched some of the adults tend to remain at the reservoir during the molt (flightless period) which can last three to four weeks. Canada Geese that do remain at Kensico during the molt period are subject to removal through depredation by the Westchester County Airport. One Mute Swan nest with 8 eggs was observed at Kensico in 2015 compared to 7 eggs in 2014 with a 100% depredation success in both years (Tables 4 and 5).

The ongoing implementation of the WMP has allowed DEP to maintain compliance with the SWTR standard for fecal coliform bacteria throughout 2014/2015 and dating back to 1993.

2. West Branch Reservoir

The 2007 FAD lists West Branch Reservoir as one of five reservoirs covered under the "as-needed" criteria for waterbird management. Since the implementation of the WMP program, only two "as-needed" actions have been implemented at West Branch. West Branch Reservoir is divided into four bird survey zones associated with reservoir water quality sampling locations (Figure 34).

Waterbird population surveys were conducted during the month of April 2014 and from August 1, 2014 through April 15, 2015 on a biweekly frequency for this reporting period as per NYSDOH's March 13, 2013 approval to reduce the routine waterbird population monitoring from weekly surveys to biweekly surveys from August 1 through April 15 annually and on an "as-needed" basis for the remainder of the year (Table 2). Additional daytime (un-aided eye) bird observations were conducted by DEP Aqueduct Monitoring staff during routine site visits. A total of 71 additional bird observations were conducted during this reporting period. The dates, times and counts for birds observed at the West Branch Effluent (Shaft 10) are listed in Table 7 unless counts were zero or no data were collected due to environmental conditions or field errors. A total of 52 out of 71 observations were reported as "0" or no birds present. During this reporting period, DEP was not required to initiate an "as-needed" bird dispersal action due to elevated fecal coliform bacteria and waterbird counts. In the event a bird dispersal action is required, DEP would implement a program using contractor personnel to eliminate the presence of waterbirds as a water quality threat.

Migratory and wintering waterbird populations at West Branch were surveyed biweekly from April 1, 2014 to April 15, 2014 and August 1, 2014 through April 15, 2015 to record annual trends which aids in identifying sources of elevated fecal coliform bacteria levels. In 2014/2015 during the overnight survey, gulls were recorded on 4 of 18 surveys with a high count of '11' on December 5, 2014 compared to only 2 of 20 surveys in 2013/2014.

Reservoir-wide total birds reached a high seasonal count of 3,132 on December 5, 2014 compared to 1,830 on December 6, 2013 recorded in the previous year (Figures 14 and 15). Duck counts, mostly Common Mergansers, generally increase annually from mid-March to late April which encompasses the northward springtime migration and again from late-September through the end of December which includes the southward migrational movements. With the onset of ice-cover in late December 2014 through early January 2015 total bird counts dropped from 894 recorded on December 30, 2014 to 6 observed on January 16, 2015.

Table 7. West Branch Reservoir – positive daytime bird observations at Delaware Effluent (Shaft 10).

Date	Time of Observation	Bird Count Range
April 3, 2014	0825	1 - 50
April 10, 2014	0942	1 - 50
April 17, 2014	0910	1 - 50
May 15, 2014	0758	1 - 50
June 26, 2014	0920	1 - 50
July 3, 2014	0804	1 - 50
July 10, 2014	0934	1 - 50
August 7, 2014	0958	1 - 50
August 14, 2014	0910	1 - 50
August 26, 2014	0908	1 – 50
September 11, 2014	0930	1 - 50
December 24, 2014	0927	Observed 1 bird
December 31, 2014	0925	1-50
April 16, 2015	1113	1 - 50
April 23, 2015	0841	1 - 50
April 30, 2015	0934	1 - 50
May 7, 2015	0854	1 - 50
May 14, 2015	0859	1 - 50
May 28, 2015	0912	1 - 50
June 4, 2015	0905	1 – 50
June 18, 2015	0950	1 - 50
June 25, 2015	0911	1 - 50
July 2, 2015	1003	1 - 50
July 17, 2015	0914	1 - 50
July 22, 2015	0947	1 - 50
July 23, 2015	0930	1 - 50

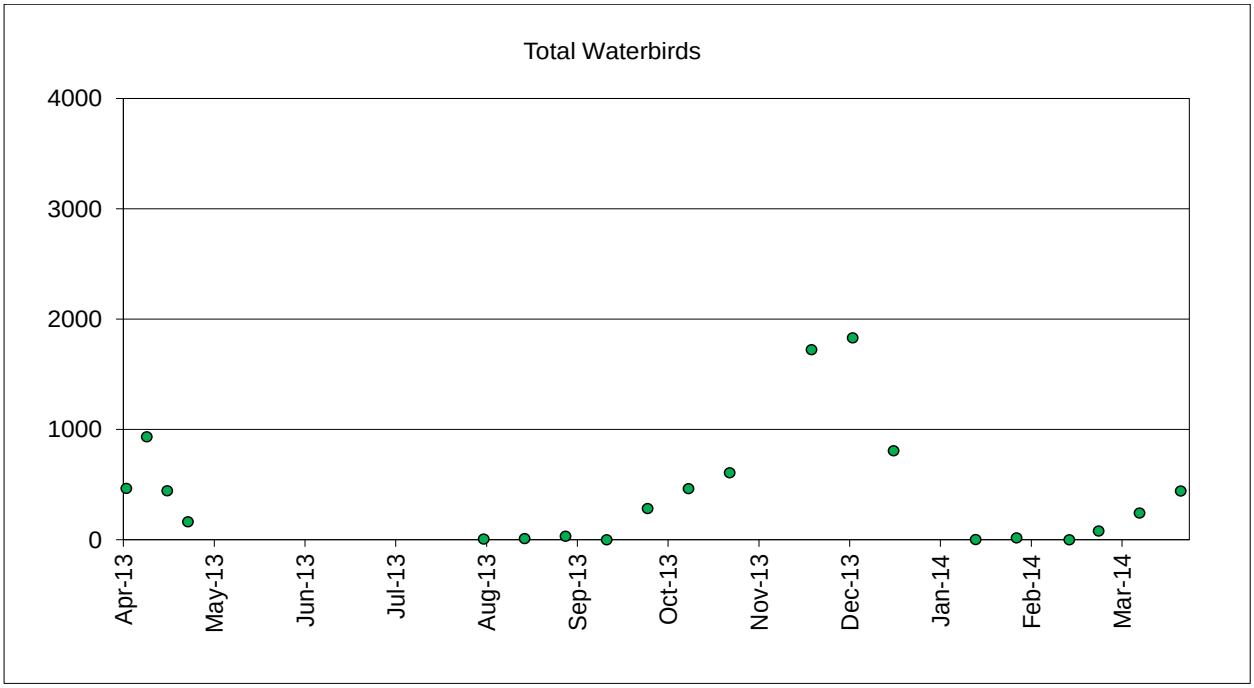


Figure 14. West Branch Reservoir total waterbirds (4/1/2013 to 4/15/2014).

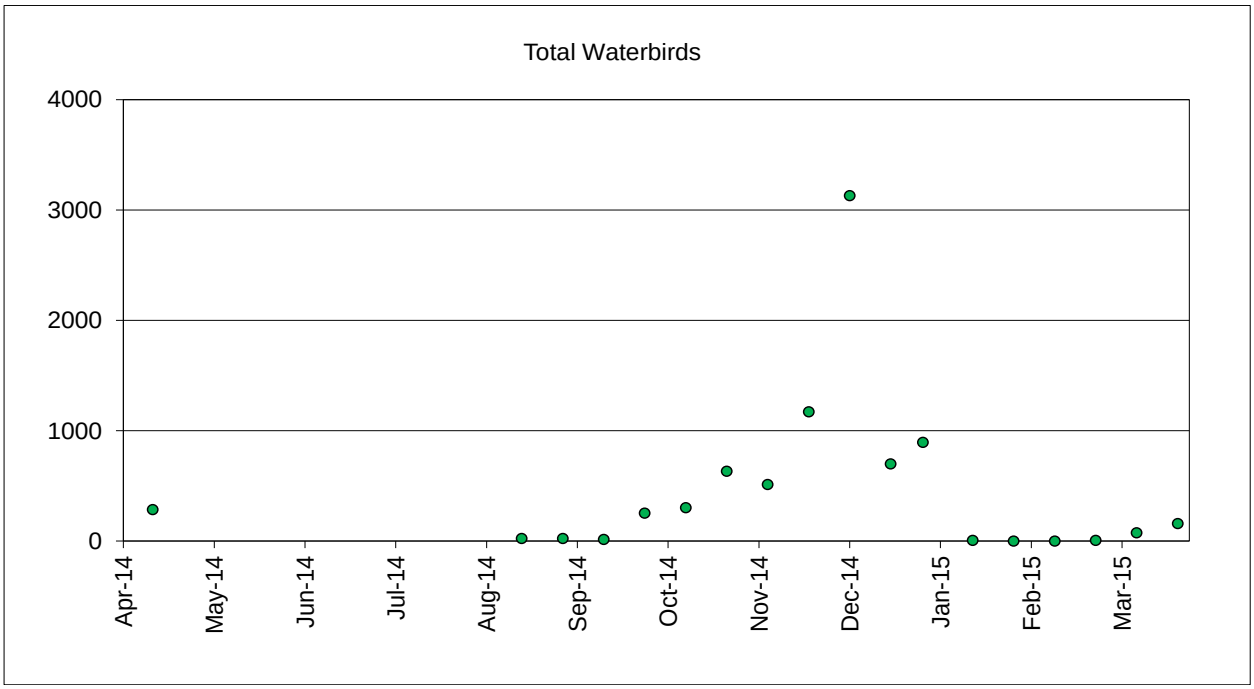


Figure 15. West Branch Reservoir total waterbirds (4/1/2014 to 4/15/2015).

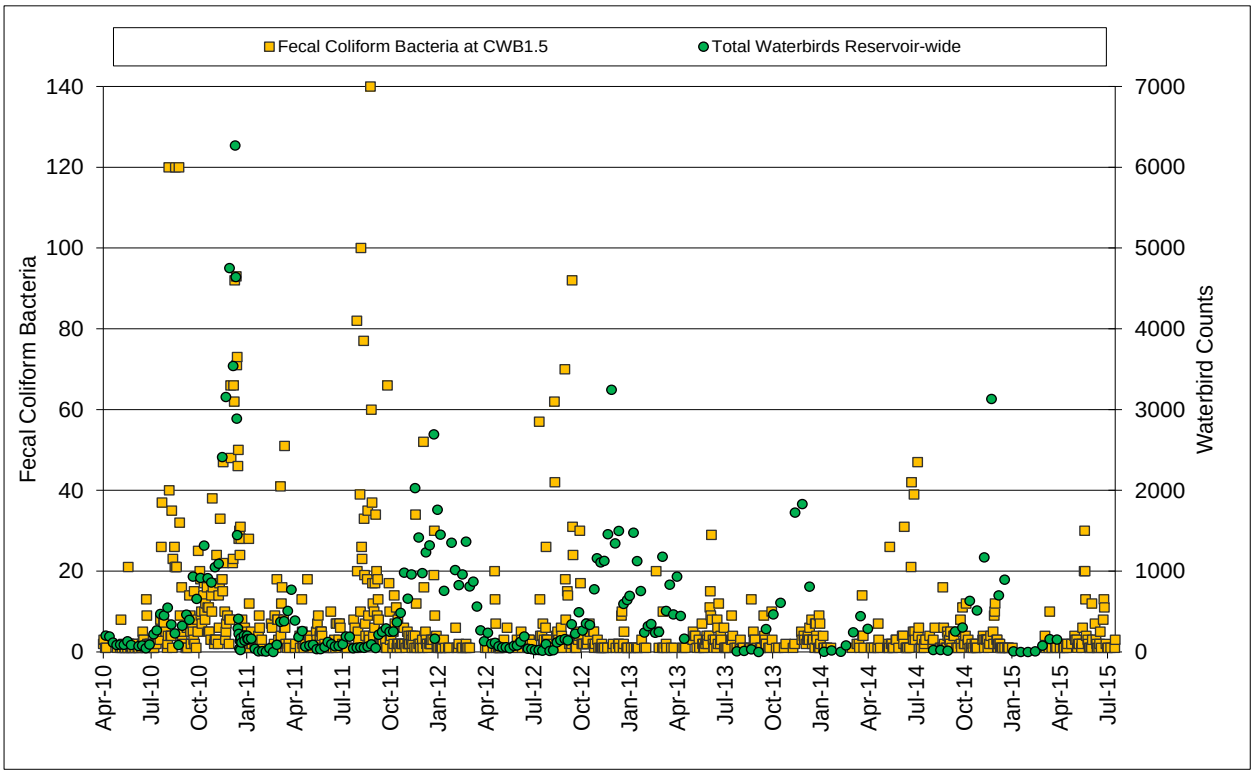


Figure 16. West Branch Reservoir fecal coliforms 100mL^{-1} at CWB1.5 vs. total waterbirds (4/1/2010 to 7/31/2015).

There were eight fecal coliform bacteria counts at or above 20 fecal coliforms 100mL^{-1} recorded at the reservoir sampling site CWB1.5 located near Delaware Shaft 10 (DEL10) from April 1, 2014 through July 31, 2015 compared to one count during the previous reporting period (Figure 16). The CWB1.5 water sampling location better represents the quality of water at West Branch Reservoir as the reservoir is often placed in 'float mode' most of the year. Since the primary trigger to implement "as needed" bird dispersal actions is the fecal coliform bacteria concentrations, DEP determined there was no need to take action during the reporting period.

DEP conducted reproductive control on Canada Geese from April 1 through May 31, 2014 and in 2015 to reduce productivity at West Branch Reservoir. In 2015, three nests with 17 eggs were depredated compared to 5 nests and 26 eggs depredated in 2014 (Tables 4 and 5). The egg-depredation was deemed 100 percent successful for both years as no goslings were observed following the nesting period. There were no Mute Swans or Double-crested Cormorants observed nesting at West Branch in 2015 or 2014 and therefore not subject to depredation actions.

3. Rondout Reservoir

Rondout Reservoir is a terminal or source water reservoir to both Kensico and West Branch. Located west of the Hudson River, Rondout is part of the Delaware System of reservoirs. The 2007 FAD lists Rondout as one of five reservoirs covered under the "as-needed" criteria for Waterfowl Management. Since the implementation of the WMP, only three "as-needed" actions have been implemented at Rondout. The Rondout Reservoir is divided into nine bird sampling geographic zones associated with reservoir water quality sampling locations (Figure 35).

Routine nocturnal waterbird population surveys were not conducted during this reporting period. DEP received approval to reduce the routine waterbird population monitoring from weekly surveys to an "as-needed" option as per NYSDOH's March 13, 2013 Letter of Approval. During this reporting period DEP was not required to initiate an "as-needed" bird dispersal action due to elevated fecal coliform bacteria and waterbird counts. In the event a bird dispersal action is required, DEP would implement a program using contractor personnel to eliminate a water quality threat.

In 2014/2015, there were no reservoir effluent samples above 20 fecal coliforms 100mL^{-1} from the Rondout Effluent compared to seven in the previous reporting period (Figure 17).

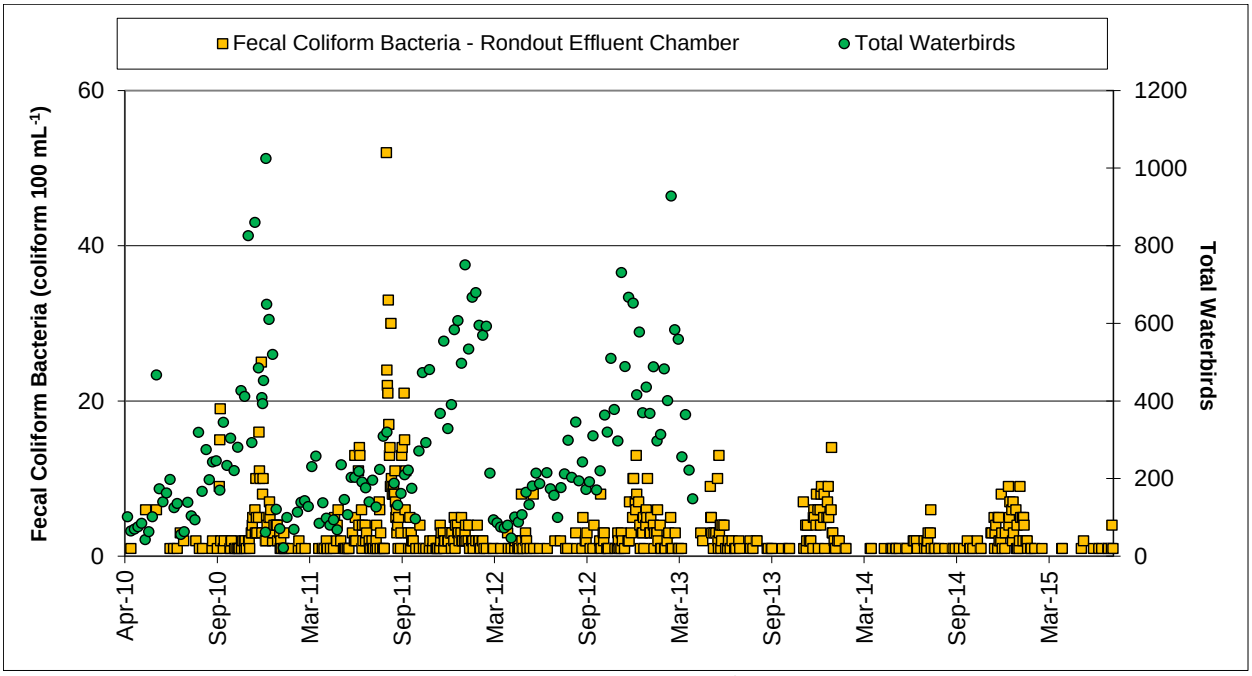


Figure 17. Rondout Reservoir fecal coliforms 100mL^{-1} at Rondout Effluent vs. total waterbirds (4/1/2010 to 7/31/2015). Waterbird surveys discontinued on 4/30/2013.

Additional daytime (un-aided eye) bird observations were conducted by DEP Aqueduct Monitoring staff during routine site visits. A total of 67 additional bird observations were conducted during this reporting period. The dates, times and count ranges for birds observed at the Rondout Effluent Chamber are listed in Table 8 unless counts were zero or no data were collected due to environmental conditions or field errors. A total of 46 out of 67 observations were reported as "0" or no birds present.

Table 8. Rondout Reservoir – positive daytime bird observations at Rondout Effluent.

Date	Time of Observation	Bird Count Range and Actual Bird Counts
June 2, 2014	0808	Observed 1 bird
June 9, 2014	1126	1 - 50
June 23, 2014	0931	1 - 50
July 7, 2014	1045	1 – 50
July 28, 2014	0908	Observed 4 birds
August 4, 2014	1019	1 – 50
August 11, 2014	0820	Observed 1 bird
September 8, 2014	0953	Observed 1 bird
September 15, 2014	0828	Observed 2 birds
November 3, 2014	1045	1 - 50
December 15, 2014	0912	Observed 2 birds
December 29, 2014	0830	Observed 2 birds
January 12, 2015	1059	1 – 50
January 20, 2015	0946	1 - 50
April 27, 2015	1000	1 - 50
May 4, 2015	1048	1 - 50
May 26, 2015	0845	Observed 1 bird
June 1, 2015	1050	1 - 50
June 8, 2015	1016	Observed approx. 25 swallows
June 22, 2015	1030	1 - 50
June 30, 2015	0903	Observed 3 ducks
July 6, 2015	0920	1 - 50
July 13, 2015	0950	1 - 50
July 20, 2015	0940	Observed 9 birds

DEP conducted routine monitoring and maintained full compliance with a protection plan for Bald Eagles (*Haliaeetus leucocephalus*) as required by the NYSDEC and United States Fish and Wildlife Service in preparation for any "as-needed" bird dispersal activity as stated in the

Findings Statement of the Environmental Impact Statement (N.Y.S. Environmental Conservation Law, Art. 8 (§8101 et seq.)) on file.

DEP also conducted reproductive control on Canada Geese at Rondout in 2014 and 2015. Due to the close proximity of some Canada Geese nests to active Bald Eagle nests DEP abstained from some goose egg and nest depredation work to maintain compliance with the New York State Endangered Species Protection Laws and USFWS Bald and Golden Eagle Protection Act (Figure 18). Four Canada Geese nests with 12 eggs were depredated during the spring of 2015 compared to 4 nests with 28 eggs depredated in 2014 (Tables 4 and 5). No goslings were documented in either 2014 or 2015 as the depredation effort was deemed 100 percent successful. There were no Mute Swan nests identified at Rondout in 2014 or 2015.

Figure 18. Adult pair of Bald Eagles in roost adjacent to Canada Goose nesting locations at Rondout Reservoir. Photo by Mike Reid.

4. Ashokan Reservoir

The 2007 FAD lists Ashokan Reservoir as one of five reservoirs covered under the "as-needed" criteria for waterbird management. Since the implementation of the WMP, no "as-needed" actions have been necessary at Ashokan. Ashokan Reservoir is divided into two main basins each with a water intake chamber located at the Dividing Weir (Figure 36). There are six waterbird sampling geographic zones, three within each basin and associated with reservoir water quality sampling locations (Figure 36).

Waterbird population surveys were suspended in May 2013 as per NYSDOH's March 13, 2013 approval to reduce routine waterbird population monitoring from weekly surveys to an "as-needed" option. Additional daytime (un-aided eye) bird observations were conducted by DEP Aqueduct Monitoring staff during routine site visits. A total of 69 additional bird observations were conducted at the Ashokan East Basin Effluent and 72 were conducted at the Ashokan West Basin Effluent during this reporting period. The dates, times and count ranges for birds observed at the Ashokan East Basin Effluent are listed in Table 9 and those for the Ashokan West Basin Effluent are listed in Table 10 unless counts were zero or no data were collected due to environmental conditions or field errors. A total of 47 out of 69 observations were reported as zero or no birds present at the East Basin Effluent and no birds were observed on 49 out of 72 observations a the West Basin Effluent.

Table 9. Ashokan Reservoir – positive daytime bird observations at Ashokan East Effluent.

Date of Observation at Ashokan East Basin	Time of Observation	Bird Count Range and Actual Bird Counts
April 9, 2014	1000	1 - 50
May 13, 2014	0959	1 – 50
June 17, 2014	1015	1 – 50
July 22, 2014	1022	Observed 25 birds
August 19, 2014	1011	Observed 1 bird
October 14, 2014	1033	1 – 50
November 3, 2014	1245	Observed 5 gulls
November 10, 2014	1244	51 - 100
December 16, 2014	1057	1 - 50
April 20, 2015	1140	1 - 50
May 4, 2015	1210	Observed 3 birds
May 11, 2015	1055	1 - 50
June 29, 2015	1023	Observed 14 birds

Table 10. Ashokan Reservoir – positive daytime bird observations at Ashokan West Effluent.

Date of Observation at Ashokan East Basin	Time of Observation	Bird Count Range and Actual Bird Counts
May 28, 2014	1157	1 - 50
June 3, 2014	1047	Observed 14 gulls
June 10, 2014	1000	1 - 50
June 17, 2014	1014	1 – 50
July 22, 2014	1021	Observed 5 birds
July 29, 2014	1117	Observed 2 birds
August 19, 2014	1010	1 - 50
August 27, 2014	1058	1 – 50
September 30, 2014	1107	1- 50
October 28, 2014	0927	1 - 50
October 31, 2014	0948	1 - 50
March 30, 2015	0956	Observed 2 birds
April 13, 2015	1102	1 - 50
May 11, 2015	1057	Observed 2 birds
May 26, 2015	1223	Observed 3 birds
June 1, 2015	1227	Observed 4 gulls
July 6, 2015	1209	Observed 5 gulls
July 13, 2015	1050	1 - 50

Since the inception of the WMP Expanded Program at Ashokan Reservoir in March 2002, DEP has not been required to initiate an "as-needed" bird dispersal action due to elevated fecal coliform bacteria and waterbird counts. In the event a bird dispersal action is required, DEP would implement a program using contractor personnel to eliminate a water quality threat.

There was only one fecal coliform sample collected at the water intake sampling location at Ashokan (EARCM) that exceeded 20 fecal coliforms $100mL^{-1}$ on October 14, 2014 (Figure 19). The Aqueduct Monitoring staff reported zero birds observed on the West Basin and one bird on the East Basin on October 14, 2014. There were no corresponding bird counts to report during the time period of April 1, 2014 through July 31, 2015.

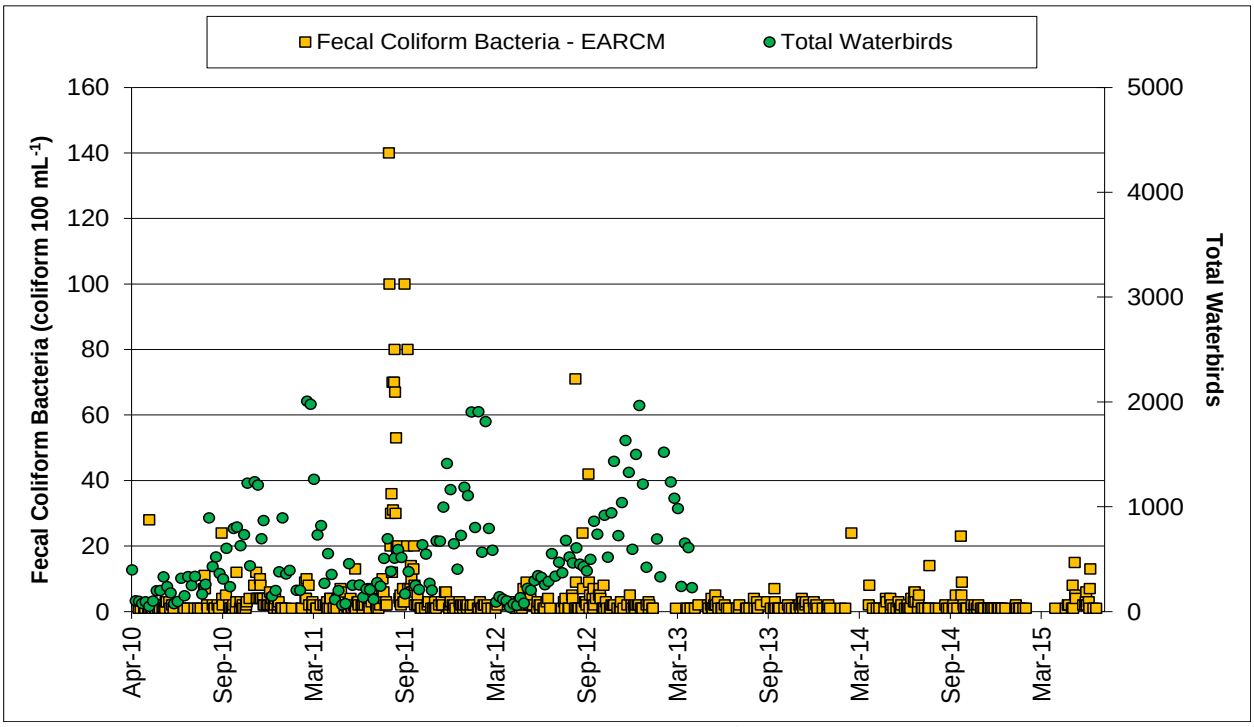


Figure 19. Ashokan Reservoir fecal coliforms 100mL^{-1} at Ashokan Effluent (EARCM) vs. total waterbirds (4/1/2010 to 7/31/2015). Waterbird surveys discontinued on 4/30/2013.

DEP conducted reproductive control on Canada Geese from April 1 through May 31, 2014 and 2015 to reduce productivity at Ashokan. In 2014, five Canada Geese nests were identified and 29 eggs addled (Tables 4 and 5). In 2015, three Canada Geese nests were observed with 14 eggs destroyed. The egg-depredation success rate at the Ashokan Reservoir in 2014 was 64 percent compared to a 70 percent success in 2015. Sixteen goslings were observed in late spring 2014 compared to 6 observed in spring 2015. There were no Mute Swans found nesting in 2014 or 2015.

5. Croton Falls Reservoir

The 2007 FAD lists Croton Falls Reservoir as one of five reservoirs covered under the "as-needed" criteria for waterbird management. Croton Falls Reservoir is divided into five bird sampling geographic zones associated with reservoir water quality sampling locations (Figure 37).

Waterbird population surveys were suspended in May 2013 as per NYSDOH's March 13, 2013 approval to reduce routine waterbird population monitoring from biweekly surveys to an "as-needed" option. As-needed actions are based on fecal coliform bacteria levels at the effluent, operational changes in water delivery and waterbird population counts. In the event a bird dispersal action is required, DEP would implement a program using contractor personnel to eliminate a water quality threat.

Nocturnal waterbird counts were not conducted during this report period. There were a total of two fecal coliform bacteria samples measured at the Croton Falls release in 2014/2015 above 20 fecal coliforms 100mL^{-1} compared to four recorded in 2013/2014 (Figure 20). -The activation of the "as-needed" waterbird dispersal program was unnecessary during this reporting period.

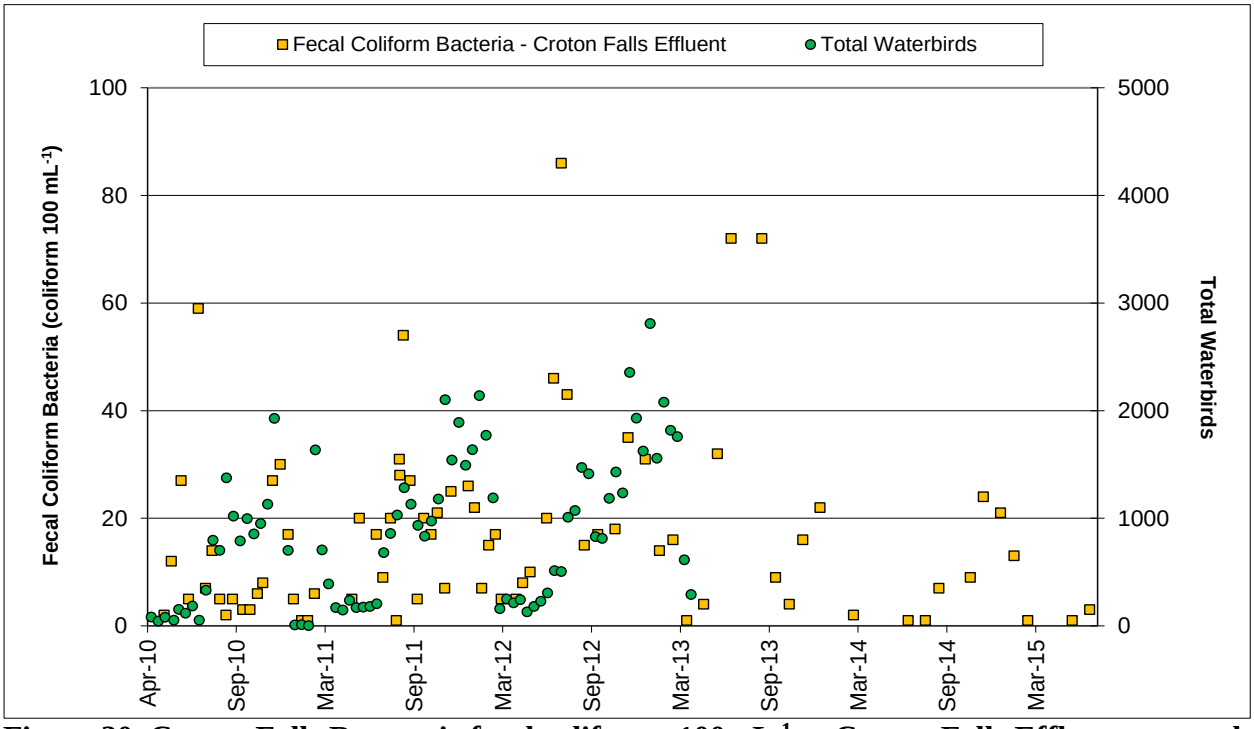


Figure 20. Croton Falls Reservoir fecal coliforms 100mL^{-1} at Croton Falls Effluent vs. total waterbirds (4/1/2010 to 7/31/2015). Waterbird surveys discontinued on 4/30/2013.

DEP conducted reproductive control on Canada Geese from April 1 through May 31 in 2014 and 2015 to reduce productivity at Croton Falls (Tables 4 and 5). In 2014, 10 Canada Geese nests were identified and 45 eggs were depredated compared to seven nests with 37 eggs in 2015. The Canada Goose egg-depredation success rate at Croton Falls for 2014 and 2015 was 100 percent for both years with no goslings that hatched in either year. There was one Mute Swan nest depredated with a total of six eggs found in 2014 and one swan nest with six eggs depredated in 2015.

6. Cross River Reservoir

The 2007 FAD lists Cross River Reservoir as one of five reservoirs covered under the "as-needed" criteria for waterbird management. Cross River Reservoir is divided into three bird sampling geographic zones associated with reservoir water quality sampling locations (Figure 38). Waterbird population surveys were suspended in May 2013 for this reporting period as per NYSDOH's March 13, 2013 approval to reduce routine waterbird population monitoring from biweekly surveys to an "as-needed" option. Since the inception of the WMP Expanded Program at Cross River in March 2002, DEP has not been required to initiate an "as-needed" bird dispersal action due to elevated fecal coliform bacteria and waterbird counts. In the event a bird dispersal action is required, DEP would implement a program using contractor personnel to eliminate a water quality threat.

Nocturnal waterbird counts were not conducted during the reporting period. Fecal coliform bacteria concentrations are reported for April 1, 2010 through July 31, 2015 (Figure 21). FCB levels in water samples at Cross River Reservoir did not exceed the 20 fecal coliforms 100mL^{-1} level from April 1, 2014 through July 31, 2015 compared to one time in the previous reporting period (Figure 21).

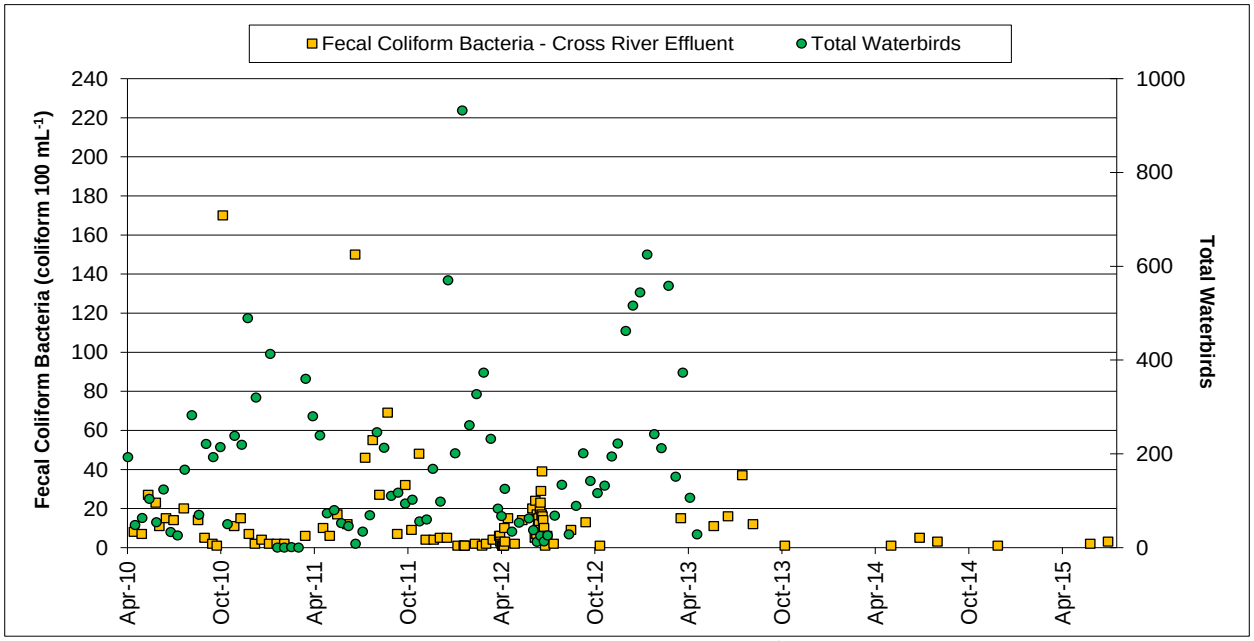


Figure 21. Cross River Reservoir fecal coliforms 100mL^{-1} at Cross River Effluent vs. total waterbirds (4/1/2010 to 7/31/2015). Waterbird surveys discontinued on 4/30/2013.

The Cross River Pump Station was not utilized during this reporting period, and activation of the "as-needed" waterbird dispersal program was unnecessary.

DEP conducted reproductive control on Canada Geese from April 1 through May 31 in 2014 and 2015 to reduce productivity at Cross River. In 2014, nine nests were identified and 48 eggs addled compared to six nests and 22 eggs in 2015 (Tables 4 and 5). The Canada Goose egg-depredation success rate for Cross River in 2014 was 100 percent with no goslings reported and at 80 percent in 2015 when four goslings were observed, as the one nest and young in 2015 were observed outside the watershed but below the dam. There were no Mute Swans observed nesting in either year.

7. Hillview Reservoir

The City's Long-Term Watershed Protection Program (July 2007 FAD) expanded the Waterfowl Management Program to include Hillview Reservoir on an "as-needed" basis similar to the 2002 FAD expansion for five additional reservoirs discussed above. DEP initiated an in-depth program for waterbird management starting in 1993 followed by program enhancements with the 2007 FAD and again in 2011 under the Hillview Administrative Order. Hillview Reservoir is divided into two bird sampling geographic zones associated with the reservoirs two distinct basins and water quality sampling stations (Figures 39 and 40). Waterbird population survey frequencies have varied through the years but generally had been conducted at a minimum on a weekly basis and in recent years on a daily basis. Bird deterrent and dispersal activities have also been employed since 1993 with a high level of success reducing and in most cases eliminating the presence of roosting waterbirds; particularly geese, cormorants, ducks, and gulls.

Prior to 1993, DEP Operations staff infrequently employed a variety of noisemakers to eliminate birds roosting diurnally and nocturnally at Hillview. During the summer of 1993, DEP's Wildlife Studies Section initiated a formal bird management program to monitor birds throughout the year and develop a bird deterrence/dispersal program. Pyrotechnics and propane operated cannons were initially used to chase the birds off the water and on reservoir shaft buildings. In July 1994, a bird deterrent wire system was partially installed which formed an aerial grid above the surface water to prevent birds such as swans, cormorants, geese, gulls and ducks from landing and defecating in the water (Figure 22). The wire grid, which was mostly completed by the spring of 1995, consisted of a combination of high-test monofilament, Kevlar wire, and twine. The grid was strung along the shoreline fences spanning a distance of nearly 1,200 feet. From 1994 to 2006, this wire grid system was maintained by DEP staff until a contract was let in 2006 to install an upgraded version of the wire deterrent system using Kevlar-coated wire strung on 15' stanchions with reel tensioning devices at the base. This work was completed in 2007. DEP staff continue to maintain the overhead bird deterrent wire system on an as needed basis.

DEP and its contractor continued to use pyrotechnics, propane cannons, remote-control motorboats, and employed physical chasing techniques to supplement the wire system to actively keep birds off the reservoir. In the winter of 2008, DEP installed remote-operated propane cannons along the reservoir's dividing wall to keep gulls and other birds from roosting on the dividing wall railings. The cannons were supplemented by installation of Daddi-Long-Legs (bird deterrent wires) placed on the tops of the 15' stanchions to prevent birds from roosting. The program enhancements were funded in association with a USEPA Administrative Order. In 2013 DEP installed a new bird deterrent wire system along the reservoir's ½ mile long dividing wall railing to keep gulls and other species from landing and roosting (Figure 23 photo of wires on railing). The newly installed railing wires have been largely successful in preventing gulls from attempting to land on the reservoir dividing wall and can be attributed to the reduced gull

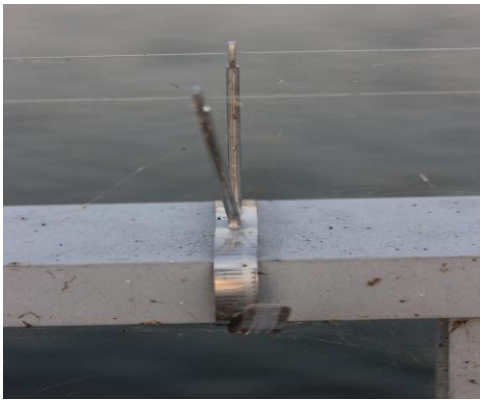
activity recorded during this reporting period.

Figure 22. Hillview Reservoir overhead bird deterrent wires. Photo by Chris Nadareski

A USEPA Administrative Order on Consent governing the covering of Hillview Reservoir (Docket No. SDWA-02-2010-8027 Catskill Delaware System) was signed on May 24, 2010. Under this order and beginning on August 1, 2011 DEP began implementing an enhanced wildlife management program at Hillview to further protect the water supply. New best management practices included increased bird census conducted daily from pre-dawn to post-dusk hours and dispersal from 5:00am until post-dusk hours; mammal population monitoring and removal; Alewife (baitfish) monitoring and removal, animal sanitation inspections (facility and grounds inspections and clean-up of animal feces); swallow spp. and sparrow management; and continued monthly reporting on wildlife management activities at Hillview Reservoir.

Overnight waterbird counts have been conducted since 1993 and daytime counts were initiated in the summer of 2004 with less frequent data collected from 1993 through 2004 (Figures 24 and 25). During the period from summer 2004 through early 2007 the overhead bird deterrent wire system was in disrepair and in preparation for replacement. Prior to bird wire mitigation in 1994, gulls comprised more than 70 percent of the night-roosting species on the reservoir. In 2014/2015 night-roosting guilds of birds comprised the following breakdown: Canada Geese 0.1 percent, Gull Spp. 0.1 percent, and ducks about 99 percent. Except for a low number of diving ducks (Ruddy Ducks, *Oxyura jamaicensis*) all waterbirds observed and

reported on both nocturnal and diurnal surveys were dispersed from the reservoir using pyrotechnics, cannons, and physical chasing from 5:00am until post-dusk times. Physical chasing of birds occurs from the time of personnel arrival starting as early as 5:00am. DEP and its contractor crews were largely successful in dispersing the gulls, geese, cormorants, and some ducks once observed.



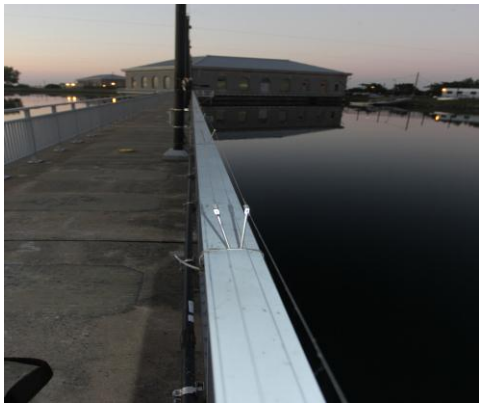


Figure 23. Hillview Reservoir bird deterrent wire system on dividing wall railing. Photos by Chris Nadareski

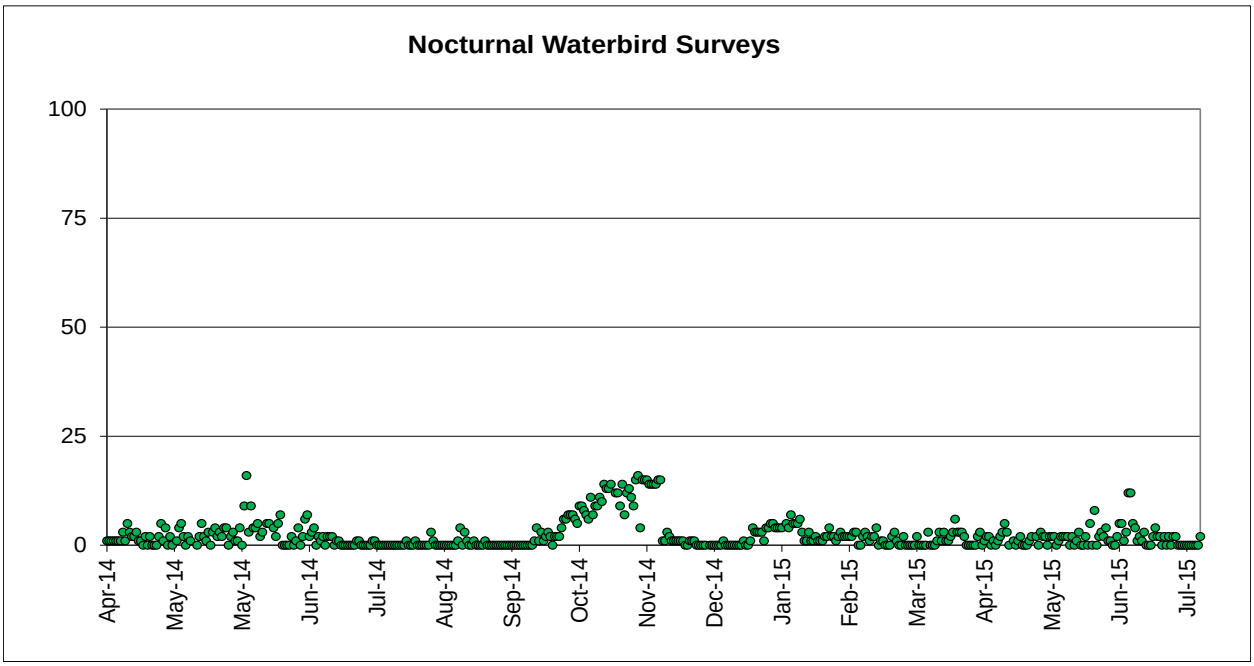


Figure 24. Hillview Reservoir total waterbirds nocturnal counts (4/1/2014 to 7/31/2015).

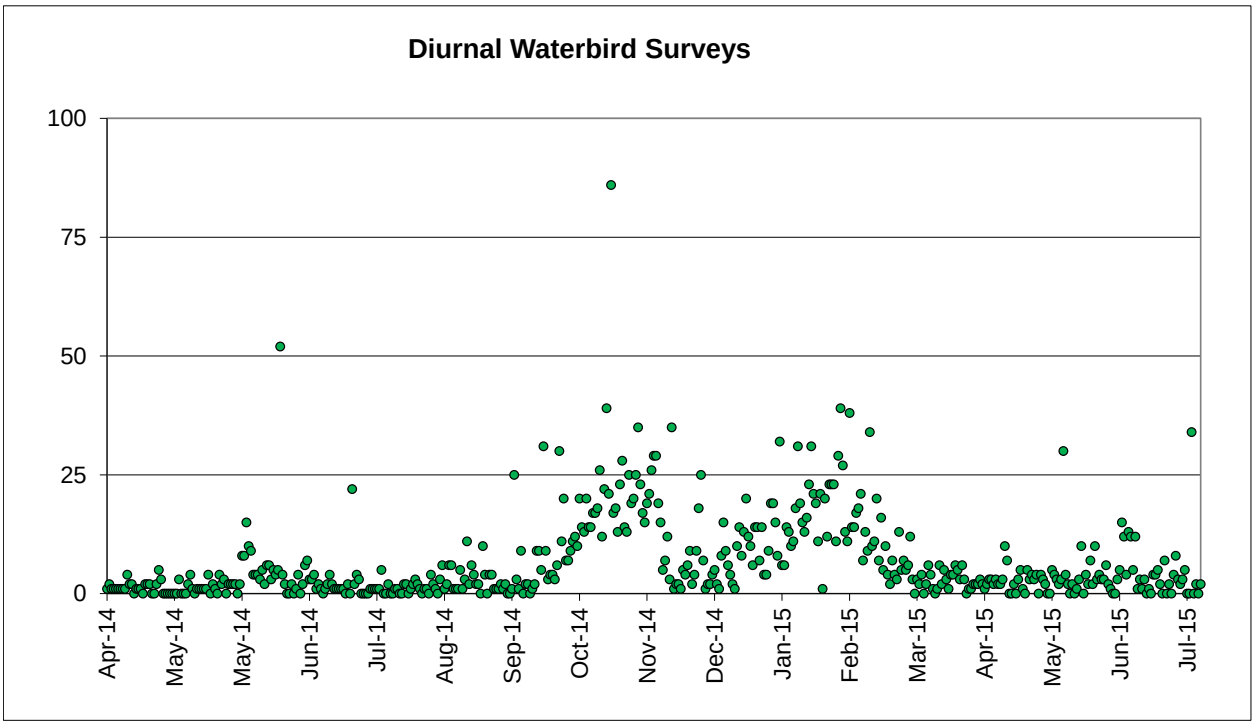


Figure 25. Hillview Reservoir total waterbirds diurnal counts (4/1/2014 to 7/31/2015).

The diving ducks (Ruddy Ducks and Bufflehead (*Bucephala albeola*)) continue to remain unaffected by a variety of bird deterrent and dispersal measures employed by DEP to date. As a result, DEP utilized contract services with United States Department of Agriculture, Wildlife Services for lethal removal of ducks during this reporting period. The lethal duck removal program was initiated in April 2011 and is conducted on an as-needed basis. A total of 17 Ruddy Ducks were lethally removed by USDA sharpshooters during this reporting period.

Overnight and daytime waterbird counts on both basins remained very low and were almost exclusively from a relatively small resident duck population during the autumn and winter. A total of 479 out of a possible 487 overnight surveys conducted were deemed successful similar to 2013/2014. An insignificant number of gulls were observed during the overnight period on 5 of 479 surveys compared to 14 in 2013/2014. On all gull nights', there was only one gull observed roosting in the reservoir. There were three observations of Canada Geese recorded during the overnight observation on June 2, 2014 (2 geese), June 16, 2014 (1 goose) and March 21, 2015 (2 geese). Overnight waterbird counts peaked at 16 on June 2, 2014 and November 23, 2014 compared to a high of 24 in the previous report. Ruddy Ducks counts on June 2nd comprised of 13/16 birds and 16/16 birds on November 23rd.

The behavior patterns of the waterbirds utilizing Hillview Reservoir are different from the other upstate reservoirs reported in the document as Hillview is situated in a highly urbanized area and surrounded by large populations of breeding gulls throughout the NYC metropolitan area. This partially explains why gull activity is present year-around at Hillview. Since the installation of the bird deterrent wire system in 1994, small numbers of gulls and two species of ducks remain the target of active dispersal activity.

Water quality results for Hillview Reservoir are presented in this report as 'number of positive *E. coli'* for each month of the reporting period at four water quality sampling locations (Figures 26-27). *E. coli* (grab samples) levels indicated a slight *E. coli* elevation from May to July 2014 entering Hillview at water quality sampling locations Site 1 when compared with samples leaving the reservoir at sampling Site 3. On three occasions, one each during May, June, and July 2014 there were five, five, and two positive *E. coli* samples reported respectively at sampling Site 3. Total reservoir-wide nightly waterbird count averages for the three months of elevated *E. coli* were as follows: May 2014 was 2.18 waterbirds/night; June 2014 was 3.82 waterbirds/night, and July 2014 was 0.77 waterbirds/night. Based on the relatively low number of waterbirds observed and the daily bird dispersal activities, it is unlikely that the waterbirds impacted the *E. coli* levels. There is however an annual increase in swallow and swift activity following the breeding season when adults and hatch-year birds are attracted to the reservoir for foraging from properties adjacent to Hillview. DEP employs an active swallow depredation program to eliminate the nesting Barn Swallows and Cliff Swallows on the reservoir buildings.

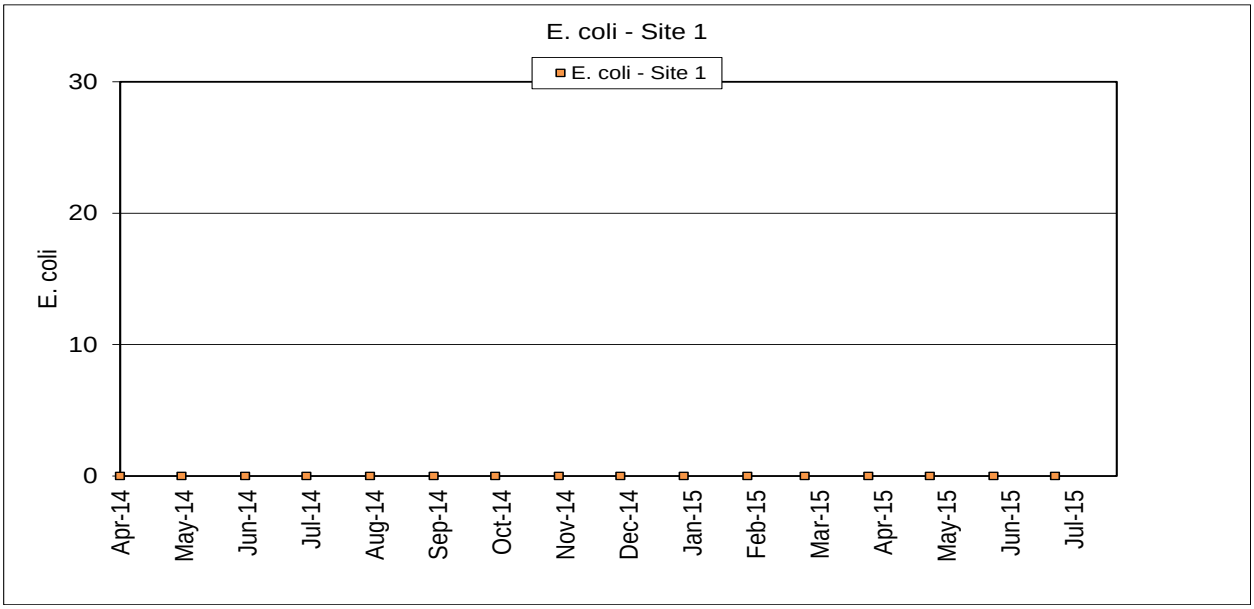


Figure 26. Hillview Reservoir number of positive *E. coli* (grab sample) at water Sampling Site 1 (4/1/2014 to 7/31/2015).

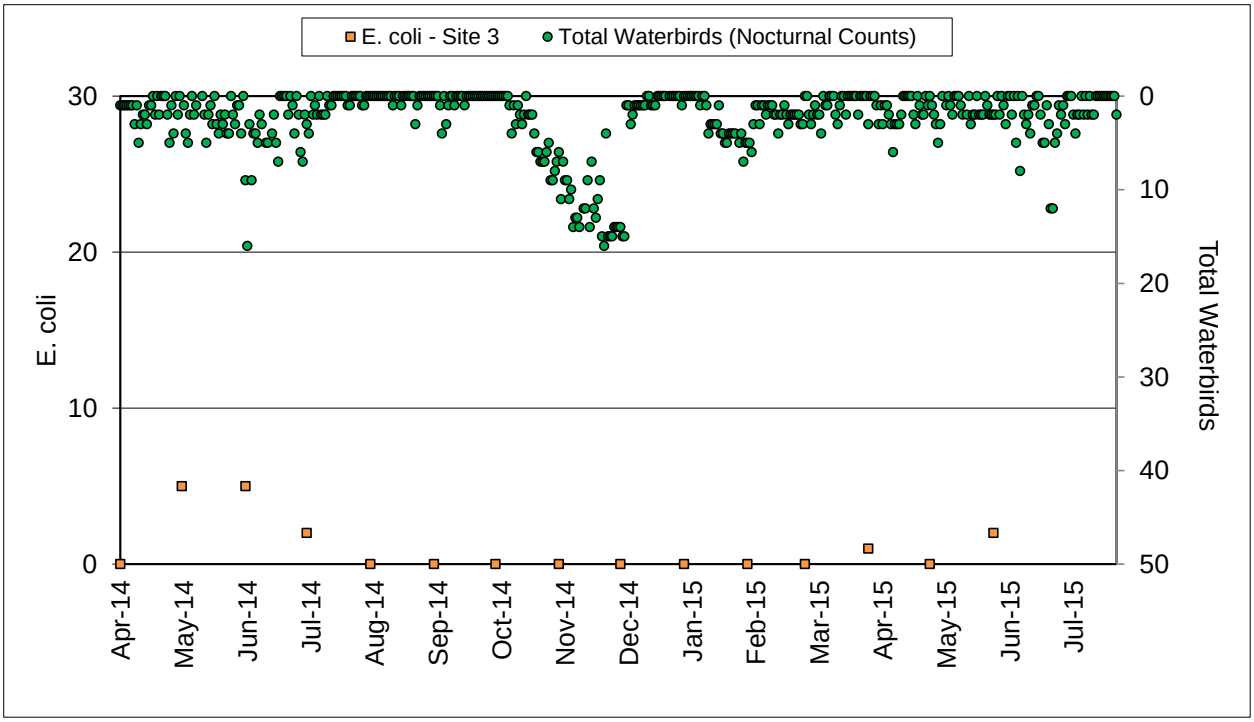


Figure 27. Hillview Reservoir number of positive *E. coli* (grab sample) versus total waterbirds at water Sampling Site 3 (4/1/2014 to 7/31/2015).

Additional actions employed by DEP working in conjunction with assistance of NYSDEC and USDA Wildlife Services included implementing the following mitigative activities:

- Winter 2008 – Present: Use of remote control propane cannons for bird dispersal along the reservoir dividing wall.
- September 2008 and February 2009 – Present: Use of remote control motor boat for dispersal.
- December 2008 – Present: Use of canoes (2008-2010 only), kayaks (2010 only), and electric motored Jon-boats for dispersal.
- September 2009 – Present: Deployment of gill nets (2010 only) and use of electric motored Jon-boats to attempt to capture ducks.
- April 2010 – Experimental lethal shooting employed by the USDA Wildlife Services.
- April 2010 - Nighttime spotlighting using electric motored Jon-boats for capturing ducks.
- July 2010 – Present: Bird netting installed and maintained on reservoir shaft buildings intake openings to preclude roosting and breeding swallow spp.

- January 2011 – Present: Submission of a monthly report on wildlife management activities to NYSDOH and USEPA.
- June 2011 – Present: USDA Wildlife Services Contract implemented to remove all resident ducks or other waterfowl that are unsuccessfully dispersed or removed by other non-lethal means implemented on an as-needed basis.
- August 2011 – Present: Under the USEPA Administrative Order and enhanced wildlife management program was implemented and includes the following:
    - Increased weekly survey shifts from 10 per week to 14 per week to allow daily, dawn to dusk coverage.
    - Daily sanitation surveys – observations and removal of animal fecal matter on the reservoir shaft buildings on the reservoir dividing wall.
    - Weekly small mammal trapping inside the reservoir perimeter fence and on the dividing wall.
    - Removal of Barn and Cliff Swallow nests (Figure 28) on the reservoir shaft buildings and Osprey nests along the dividing wall bird wire stanchions. Nest removal activity approved by USFWS following the birds' breeding season in autumn of 2011 and 2012.
    - Collection and disposal of alewives (baitfish) from the Uptake 1 facility (water received from Kensico Reservoir). Removal of Alewives facilitates the elimination of waterbird foraging activity and roosting at the reservoir.
- May 2012 – Present: Expanded access for USDA Wildlife Services Contract sharpshooters to discharge firearms from reservoir dividing wall to improve duck depredation efficiency.
- January 2013 - Present: Received USFWS depredation permit for Cliff Swallows, Barn Swallows, and Mallard nest/egg/young removal during the breeding season.
- 2013 – Present: Completed installation and continued maintenance of avian deterrent wire system on reservoir dividing wall railing.
- 2013 – Present: Expanded access for USDA Wildlife Services Contract sharpshooters to discharge firearms from Jon boats to improve duck depredation efficiency.
- July 2014 – Present: Expanded number of live mammal traps along reservoir perimeter.
- 2014 – Present: Installed additional motion activated cameras to document wildlife access at gate entrances to reservoir.

Figure 28. Barn Swallow nest constructed of mud and grass and lined with feathers and horsetail hair from the nearby racetrack removed from shaft buildings. Photo by Chris Nadareski

Mammal Trapping

DEP initiated a year-around mammal trapping program in August 2011 and currently employs trapping efforts for raccoons and other mammals each week of the year. Traps were generally set around the Downtake 1 and Uptake 1 perimeter catwalks and along the reservoir shoreline close to the shaft buildings. A variety of commercial and supermarket-type trapping baits have been used with variable success. Traps have been outfitted with catchment plates to avoid release of fecal material into the reservoir from trapped animals. All traps are secured with wires to the shoreline fence to prevent trap roll-overs. To date, mice and raccoons (*Procyon lotor*) have been the most frequently trapped species. Other mammals trapped and subsequently depredated under New York State Department of Environmental Conservation approval include striped skunk (*Mephitis mephitis*), Virginia opossum (*Didelphis virginiana*), mice (*Peromyscus* Spp.), meadow vole (*Microtus pennsylvanicus*), eastern gray squirrel (*Sciurus carolinensis*),

Norway rat (*Rattus norvegicus*), northern short-tailed shrew (*Blarina brevicauda*) and feral cat.

Table 11. Mammal trapping summary April 2014 through July 2015.

Month/Year	Number of Live-traps Set	Trapping Success
April 2014	168	1 Opossum removed
May 2014	144	1 Opossum removed
June 2014	129	1 Raccoon removed and 1 Feral Cat relocated
July 2014	202	4 Raccoons, 3 Striped Skunks, 1 Norway Rat, and 7 Peromyscus Spp., removed and 1 Feral Cat relocated
August 2014	266	1 Striped Skunk, 1 Opossum, and 4 House Mice removed
September 2014	330	3 Striped Skunks and 1 House Mouse removed and 2 Feral Cats relocated
October 2014	396	1 Opossum, 1 Gray Squirrel, and 5 House Mice removed
November 2014	264	3 House Mice removed
December 2014	330	2 House Mice removed
January 2015	286	No animals removed
February 2015	308	No animals removed
March 2015	330	2 Opossum, 4 White-footed Mice and 1 House Mouse removed
April 2015	396	1 White-footed Mouse removed
May 2015	396	1 White-footed Mouse removed
June 2015	374	1 Raccoon, 1 Striped Skunk, 1 House Mouse, and 1 White-footed Mouse removed
July 2015	396	2 Raccoons and 1 Striped Skunk removed

In 2014/2015 a total of 4,715 traps were set during the period April 1 2014 to July 31, 2015 (Table 11). An additional 722 traps were set from April 1, 2014 to March 31, 2015 when compared to 2,431 traps set in 2013/2014 during the same time period. Three raccoons were successfully removed through July 2015 compared to six in 2014. The success of the trapping program is displayed in Table 12 and Figure 29. A total of 108 mammals from 10 species have

been live-trapped inside the reservoir perimeter fence from 2011 to 2015 (Table 12). All trapped specimens were euthanized and subsequently composted at the DEP Animal Compost Facility located in Ulster County. A total of 8,013 mammal trapping nights have been set since August 2011. A single mammal trapping night consists of one trap baited for one night.

Table 12. Trapping success summary for Hillview Reservoir (August 2011 to July 2015)

Species Trapped	**2011 (August 1 to December 31)**	**2012**	**2013**	**2014**	**2015**	**Trapping totals by species**
Raccoon	8	5	6	6	3	**28**
Striped Skunk	0	1	0	7	2	**10**
Opossum	0	0	0	4	6	**10**
Mice (*Peromyscus* Spp.)	7	0	11	7	7	**32**
Meadow Vole	0	0	4	0	0	**4**
Short-tailed Shrew	0	0	1	0	0	**1**
House Mouse	0	0	0	21	2	**23**
Norway Rat	0	0	0	1	0	**1**
Gray Squirrel	0	0	0	1	0	**1**
Feral Cat (relocated)	0	0	0	4	0	**4**
Annual Trapping totals	**15**	**6**	**16**	**51**	**20**	**108**

Trapping success also increased for striped skunks from zero in 2013 to nine in 2014, Opossum from zero in 2013 to four in 2014 and six to date in 2015, *Peromyscus* Spp. decreased from 11 in 2013 to seven each in 2014 and 2015, and house mice from zero to 21 in 2014. The increase in trapping success may largely be attributed to a large increase in the number of traps set, in addition to setting at new trapping locations around the reservoir.

As part of the ongoing wildlife management initiatives, nighttime remote sensing cameras have been used to document the presence or absence of wildlife on the reservoir dividing wall and catwalks surrounding the shaft buildings at Hillview. Figure 30 represents the

occurrence of nighttime remote camera photographs of animals on both nights that traps were set and not set versus the trapping success. The number of camera hits of wildlife appear to peak from August through October which represents many nights of repeated visits by a feral cat and Norway rat. The late winter of 2015 (March) coincides with the raccoon breeding cycles and young present. High counts of camera detection nights may also represent repeated

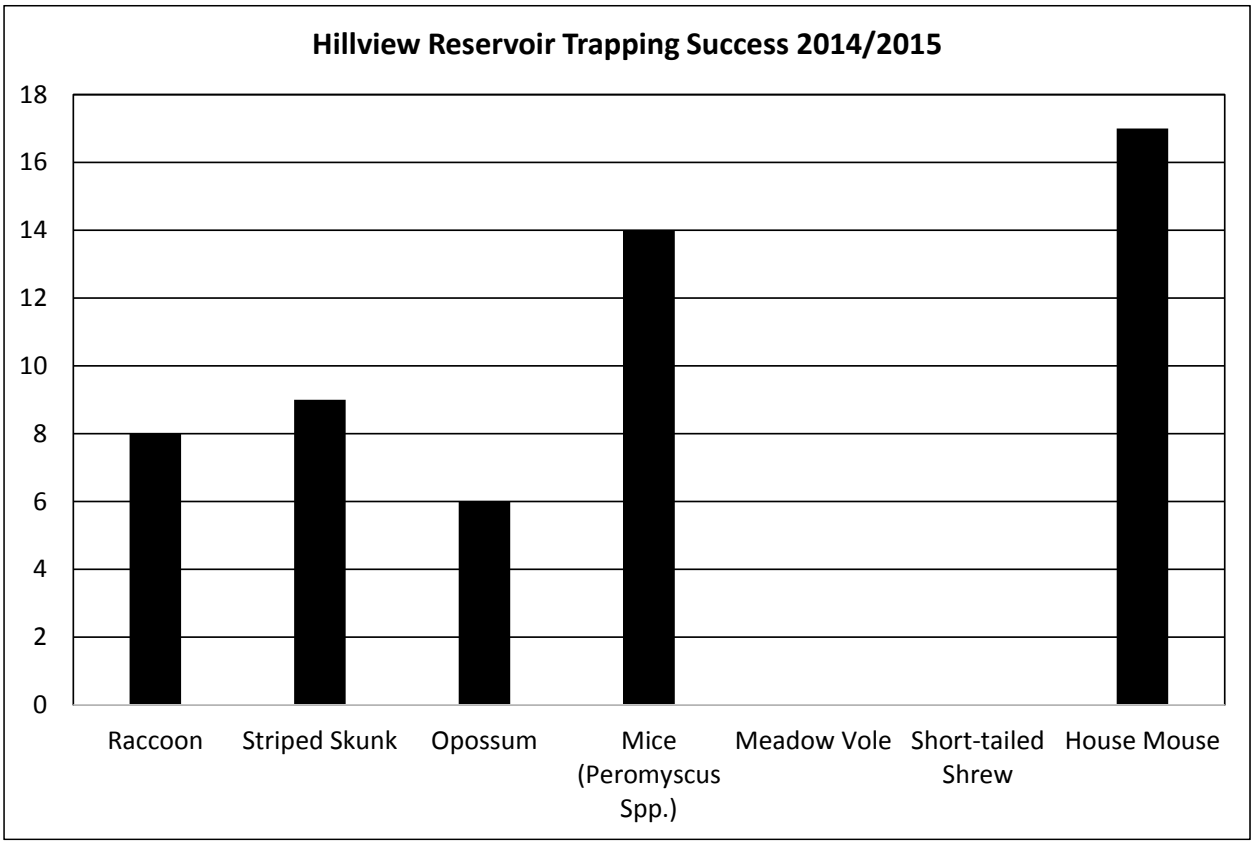


Figure 29. Mammal species trapped at Hillview Reservoir (April 2014 to July 2015).

photographs of the same individual. Raccoons are known to breed during the late winter period and have a 63 day gestation period which would suggest birthing in early spring. Raccoon home range can be two to four miles and extend to further distances during the autumn whereby the occurrence increase in the autumn may be attributed to these movements. The low camera detection and trapping success rate during the winter may be attributed to a lack in insect-type food that attracts them to the reservoir dividing wall, extended period of snow cover, and surface ice on the reservoir. The low detection rate of raccoons during the summer may be a result of alternate available feeding locations including berries and seeds found in the surrounding suburban neighborhoods and habitat.

During the 2014/2015 waterbird nesting season there were no reported nesting attempts by Canada Geese or Mute Swans however two Mallard nests were identified and subsequently depredated under permit. For comparison, a total of 23 Mallard eggs were depredated from May through July in 2014 and 10 Mallard eggs depredated during the same time period in 2015. One of three nests produced a total of six ducklings in 2014 and one of two nests in 2015 hatched 12 ducklings that were promptly live-captured and delivered to wildlife rehabilitators for captive raising and subsequent released at locations distant from Hillview Reservoir. The Mallard egg depredation success rate was 79 percent in 2014 compared to 45 percent in 2015.

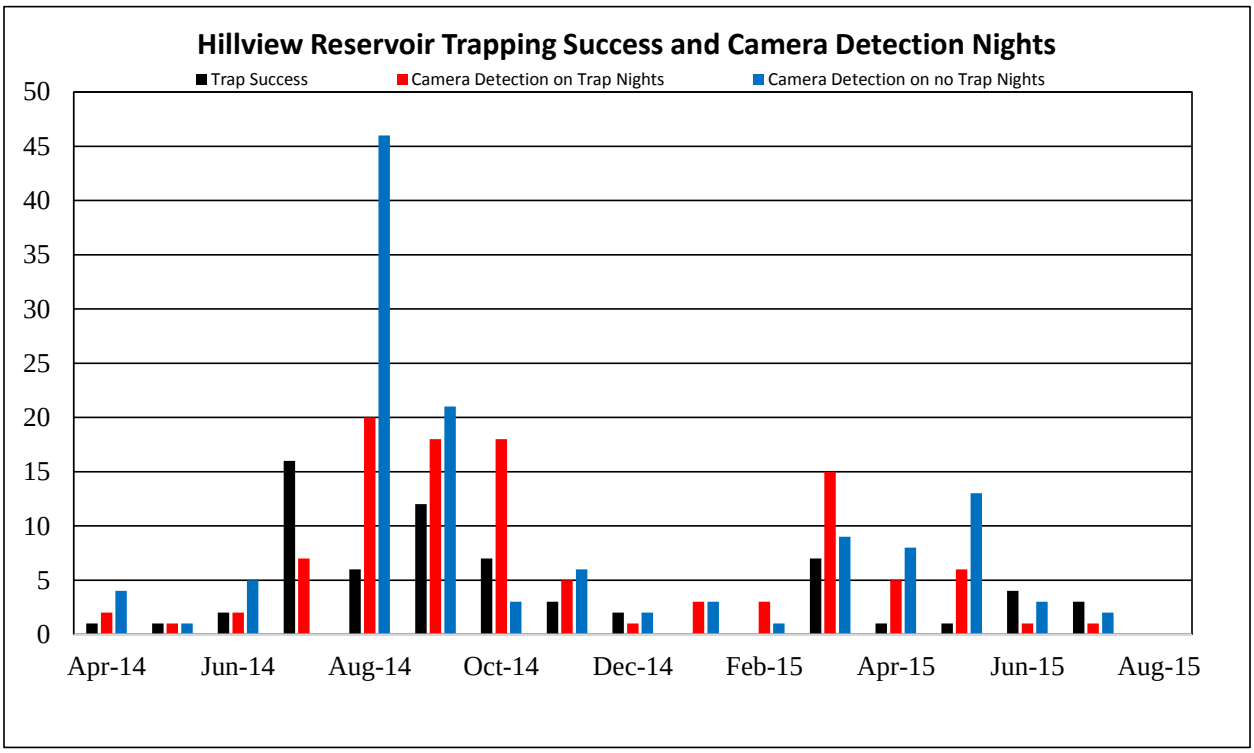


Figure 30. Occurrences of remote nighttime photography of animals recorded on the reservoir catwalk and dividing wall versus trapping success (April 2014 to July 2015).

CONCLUSION

DEP's Waterfowl Management Program is a key component to the City's continuance of Filtration Avoidance as outlined under the Revised 2007 Filtration Avoidance Determination. The program has helped DEP maximize options for delivering high quality water into distribution. The Waterfowl Management Program has been in continuous operation since 1993 and continues to effectively reduce waterbird populations and reduce fecal coliform bacteria levels which have assisted DEP in maintaining compliance with the Environmental Protection Agency's Surface Water Treatment Rule as part of the Safe Drinking Water Act (42 U.S.C. §300f et seq.) regulations.

The reduced waterbird and related fecal coliform bacteria counts at Kensico Reservoir and Hillview Reservoir can be attributed directly to the variety of bird dispersal and deterrence techniques. When dispersal tools (motorboats, airboats, propane cannons, and pyrotechnics) are used in a variety of combinations they result in the most effective means to bird reduction over large open areas of drinking water. To date, it remains inconclusive what the tolerable number of waterbirds is at NYC reservoirs before water quality is compromised; therefore, the objective of the Waterfowl Management Program will be to continue with the an active bird dispersal program during the bird migratory seasons for Kensico and year-around at Hillview Reservoirs and on an "as-needed" basis for reservoirs that are source to Kensico.

The establishment of bird-free zones (spatial distributions) around the water intake structure at Kensico Reservoir, whether program-initiated through bird dispersal activities or by the natural process of the birds selecting roosting locations, continues to be a key influence on lower fecal coliform bacteria levels. The spatial distributions of the birds in relation to the flow dynamics of the reservoir appear to have the greatest influence in the transport of bacteria to the water intakes. It is evident that when DEP properly manages its waterbird populations, bird-related fecal coliform bacteria concentrations have remained low.

Bird deterrence measures which include waterbird reproductive management, bird deterrent netting, overhead bird deterrent wires, and shoreline fencing continued to reduce local breeding opportunities around water intake structures and eliminate fecundity during this reporting period. DEP will continue to consider options as deemed necessary for Canada Geese and Mute Swan management to reduce local breeding populations by means of "take" under federal and state depredation permits. The "take" option was utilized by the USDA as part of the Westchester County Airport depredation order to remove local Canada Geese during this reporting period. The removal of locally breeding Canada Geese helps break the strong nest-site fidelity these birds exhibit particularly with a species that may survive more than 20 years as a breeder.

At Hillview Reservoir, DEP continued to employ the use of pyrotechnics, physical

chasing, remote-operated propane cannons, remote-control motorboats, Daddi-Long-Legs, bird deterrent wires and netting to prevent terrestrial and waterbird species from landing on the reservoir dividing wall, and including additional lethal control measures to manage ducks, geese, swallows and sparrows. Remote-operated propane cannons have improved bird deterrence during times of inclement weather when DEP and contractor staffs are not permitted on the reservoir dividing wall and pyrotechnics are rendered ineffective from the reservoir shoreline. As a part of the USEPA Administrative Order, DEP has initiated small mammal trapping inside the reservoir perimeter fence and on the reservoir dividing wall. In 2014/2015 a total of 4,715 traps were set; an increase from the 2013/2014 reporting period. A total of 20 mammals were successfully removed compared to 51 mammals and two birds in the previous report. DEP is permitted under federal and state law to remove the swallow nests. A total of 11 Barn Swallow (*Hirundo rustica*) and 22 Cliff Swallow (*Petrochelidon pyrrhonota*) nests were removed from the reservoir shaft buildings from April 2014 through July 2015 compared to 86 Swallow nests depredated in 2013; the decrease most likely a result of the intensive depredation efforts. DEP received a federal depredation permit for 2014 and 2015 to remove active swallow nests during the nesting period at Hillview Reservoir.

Waterbird populations continue to demonstrate seasonal elevations primarily during the autumn and winter periods in all reservoirs listed in this report. Climate alterations can affect behaviors and migratory activity changes of "local" or resident birds such as Canada Geese. Gull populations are migratory and utilize the New York City Reservoir system as a migratory stop-over or wintering area until local conditions (i.e. ice and snow cover) become too intolerable. Ice cover on the reservoirs and snow cover in the associated watershed or daily flight range for food often determine whether they will continue in migration or utilize the reservoirs.

DEP continues to remain in compliance with SWTR regulations, with low seasonal elevations of fecal coliform bacteria recorded annually from late autumn through early winter. Monitoring the effects that bird dispersal measures have on each reservoir has been achieved through over two decades of routine water quality monitoring, population surveys and identifying bacteria origins. Avian population survey results have provided inferences about the potential effects of avian fecal matter based on the spatial and temporal aspects of the birds and have also assisted DEP in evaluating the effectiveness of the dispersal measures. DEP will continue with the implementation of the Waterfowl Management Program as part of its Filtration Avoidance Program to protect water quality by managing waterbird populations.

REFERENCES

Alderisio, K.A. and N. DeLuca. 1999. Seasonal enumeration of fecal coliform bacteria from the feces of Ring-billed Gulls (*Larus delawarensis*) and Canada Geese (*Branta canadensis*), Applied and Environmental Microbiology 65:5628-5630.

Benton, C., F. Khan, P. Monaghan, W.N. Richards and C.B. Shedden. 1983. The contamination of a major water supply by gulls (Larus sp.). Water Resources 17(7):789-798.

Gould, D.J. and M.R. Fletcher. 1978. Gull droppings and their effects on water quality. Water Research 12:665-672.

Hussong, D., J.M. Damare, R.J. Limpert, W.J.L. Sladen, R.M. Weiner, and R.R. Colwell. 1979. Microbial impact of Canada geese (*Branta canadensis*) and Whistling swans (*Cygnus columbianus columbianus*) on aquatic ecosystems. Appl. Environ. Microbiol. 37, 14–20.

Levesque, B., P. Brousseau, P. Simard, E. Dewailly, M. Meisels, D. Ramsay, and J. Joly. 1993. Impact of ring-billed gulls (Larus delawarensis) on the microbiological quality of recreational water. Applied and Environmental Microbiology 59:1228-1230.

New York City Department of Environmental Protection (DEP). 1992. Kensico Watershed Study 1991-1992. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1993. Kensico Watershed Study 1991-1993. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1994. Kensico Watershed Study Augmented Annual Research Report, January 1993-March 1994. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1995. Kensico Watershed Study Annual Research Report, April 1994-March 1995. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1996. Kensico Watershed Study Annual Research Report, April 1995-March 1996. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1997. Kensico Watershed Study Annual Research Report. April 1996-March 1997. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1997a. West Branch Drainage Basin Report, A Preliminary Data Review for Planning. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1998. Kensico Watershed Study Annual Research Report. April 1997-March 1998. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 1999. Kensico Watershed Study Annual Research Report. April 1998-March 1999. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2000. Kensico Watershed Study Annual Research Report. April 1999-March 2000. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2001. Kensico Watershed Study Annual Research Report. April 2000-March 2001. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2002. Continue Implementation of Final Waterfowl Management Plan. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2003. Waterfowl Management Program. July 31, 2003. Division of Drinking Water Quality Control, Valhalla, NY

New York City Department of Environmental Protection (DEP). 2004. Waterfowl Management Program. July 31, 2004. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2005. Waterfowl Management Program. July 31, 2005. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2006. Waterfowl Management Program. July 31, 2006. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2007. Waterfowl Management Program. July 31, 2007. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2008. Waterfowl Management Program. July 31, 2008. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2009. Waterfowl Management Program. July 31, 2009. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2010. Waterfowl Management Program. July 31, 2010. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2011. Waterfowl Management Program. July 31, 2011. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2012. Waterfowl Management Program. July 31, 2012. Division of Drinking Water Quality Control, Valhalla, NY.

New York City Department of Environmental Protection (DEP). 2013. Waterfowl Management Program. September 30, 2013. Bureau of Water Supply, Watershed Water Quality Operations, Wildlife Studies Section, Kingston, NY.

New York City Department of Environmental Protection (DEP). 2014. Waterfowl Management Program. September 30, 2014. Bureau of Water Supply, Watershed Water Quality Operations, Wildlife Studies Section, Kingston, NY.

New York City Department of Environmental Protection (DEP). 2014. Watershed Water Quality Annual Report. September 30, 2014. Bureau of Water Supply. Kingston, NY.

New York State Department of Health (NYSDOH). 2013. Letter of Approval.

New York State Department of Health (NYSDOH in Consultation with USEPA). 2014. New York City Filtration Avoidance Determination.

Standridge, J.H., J.J. Delfino, L.B. Kelppe, and R. Butler. 1979. Effect of waterfowl (*Anas platyrhynchos*) on indicator bacteria populations in a recreational lake Madison, Wisconsin. Applied Environmental Microbiology. 38(3), 547–550.

USEPA (U.S. Environmental Protection Agency). 1989. Drinking Water: National Primary Drinking Water Regulations; Filtration, Disinfection; Turbidity, Giardia lamblia, Viruses, Legionella, and Heterothrophic Bacteria; Final Rule. 54 Fed. Reg. 27486. June 29, 1989. WH-FRL-3607-7. Washington, D.C.

USEPA (U.S. Environmental Protection Agency). 2007. New York City Filtration Avoidance Determination. http://www.epa.gov/region2/water/nycshed/2007finalfad.pdf

Appendix A. Reservoir maps with bird zone designations and water sampling locations

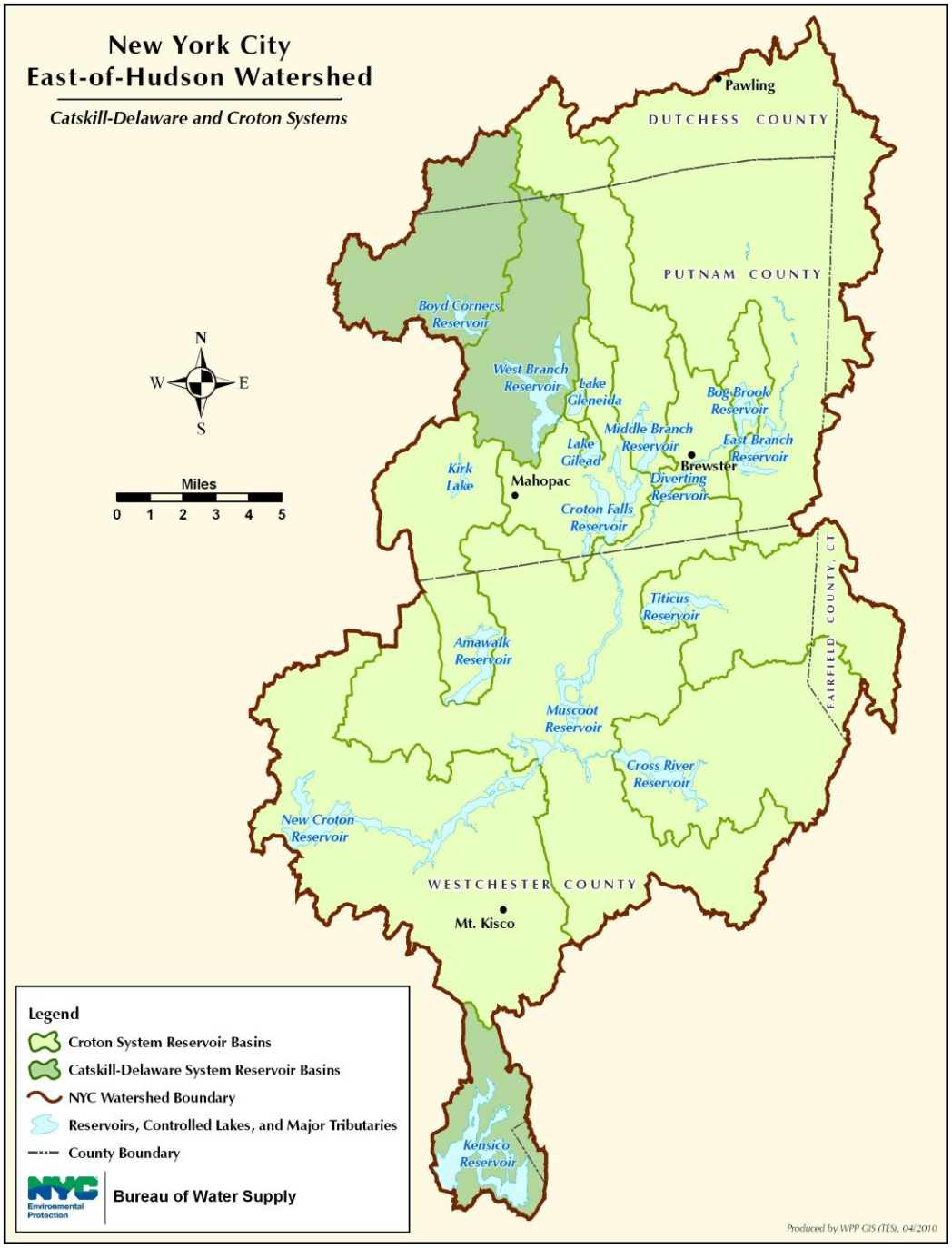


Figure 31. Map of New York City Water Supply System – East of Hudson Region.

Figure 32. Map of New York City Water Supply – West of Hudson Region.

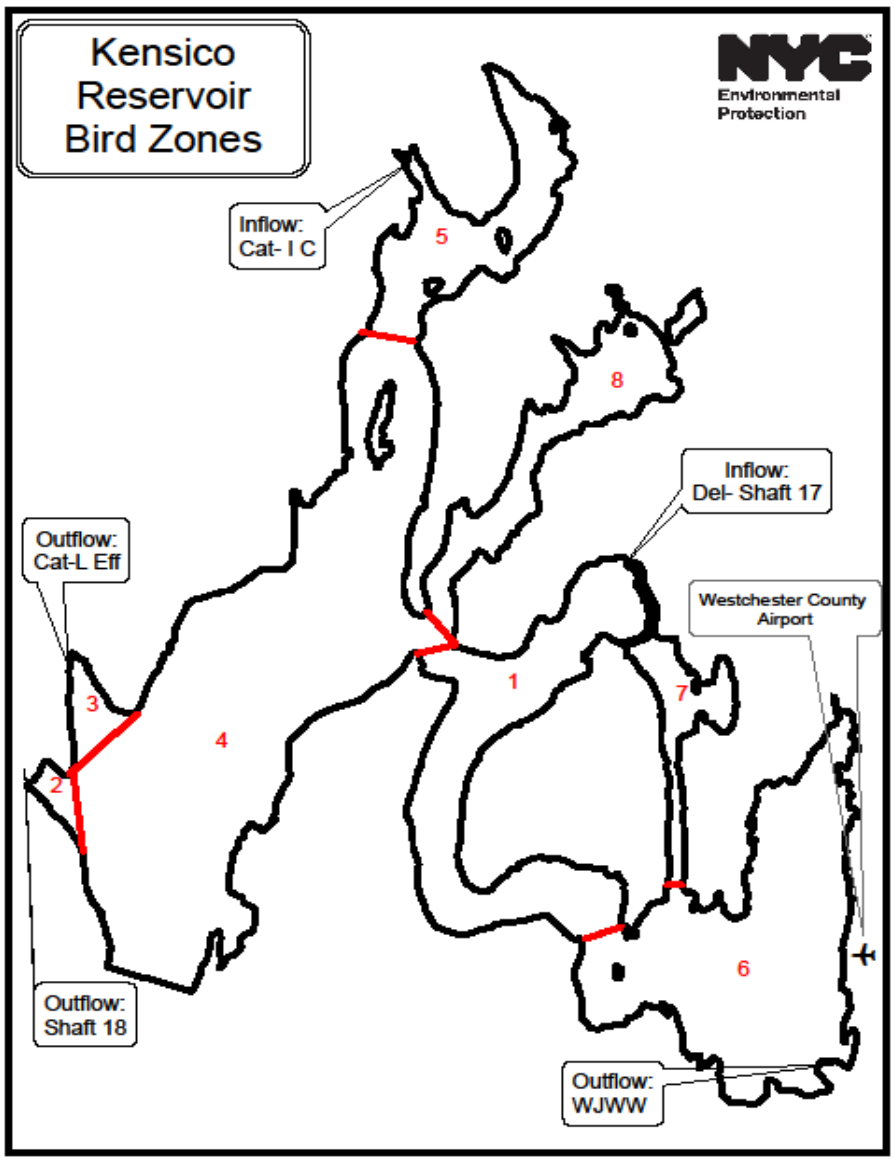


Figure 33. Map of Kensico Reservoir bird zones.

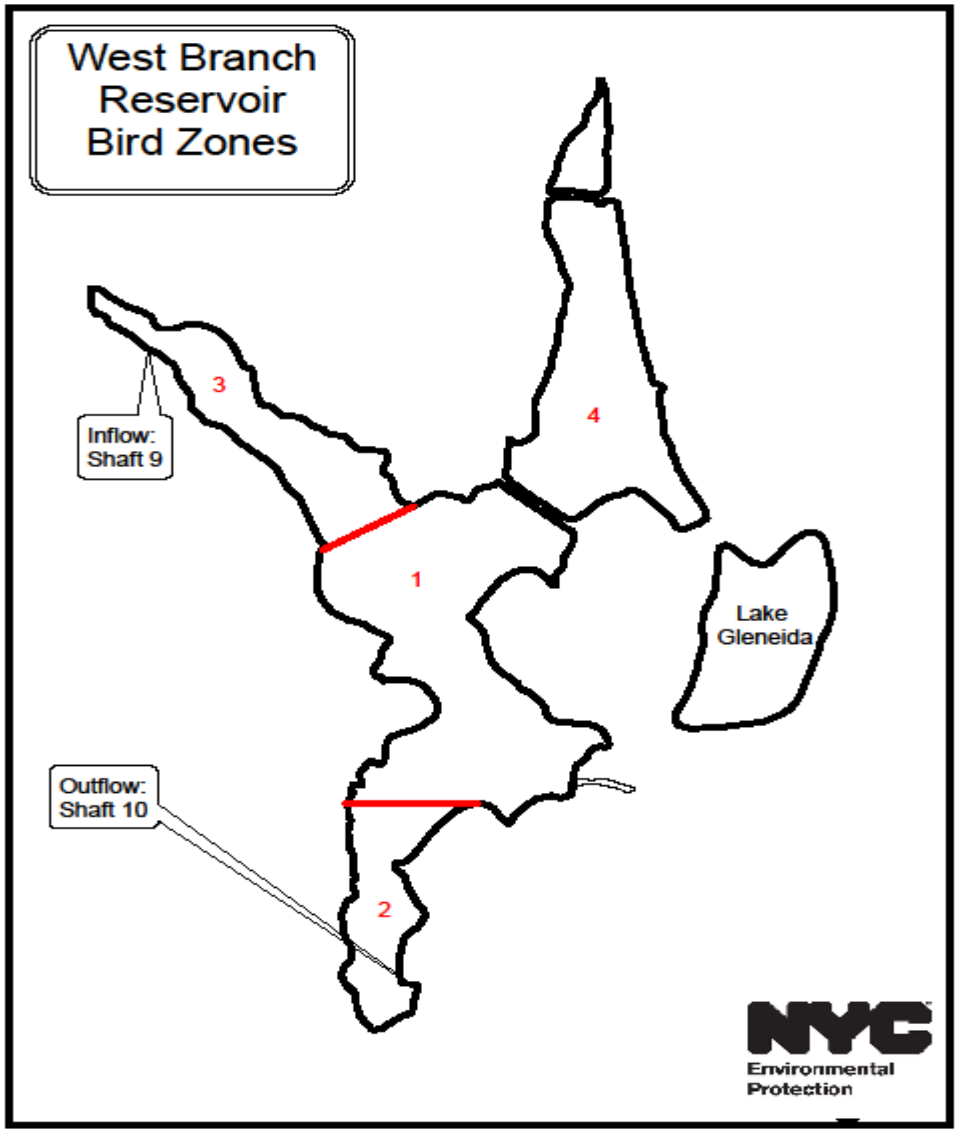


Figure 34. Map of West Branch Reservoir bird zones.

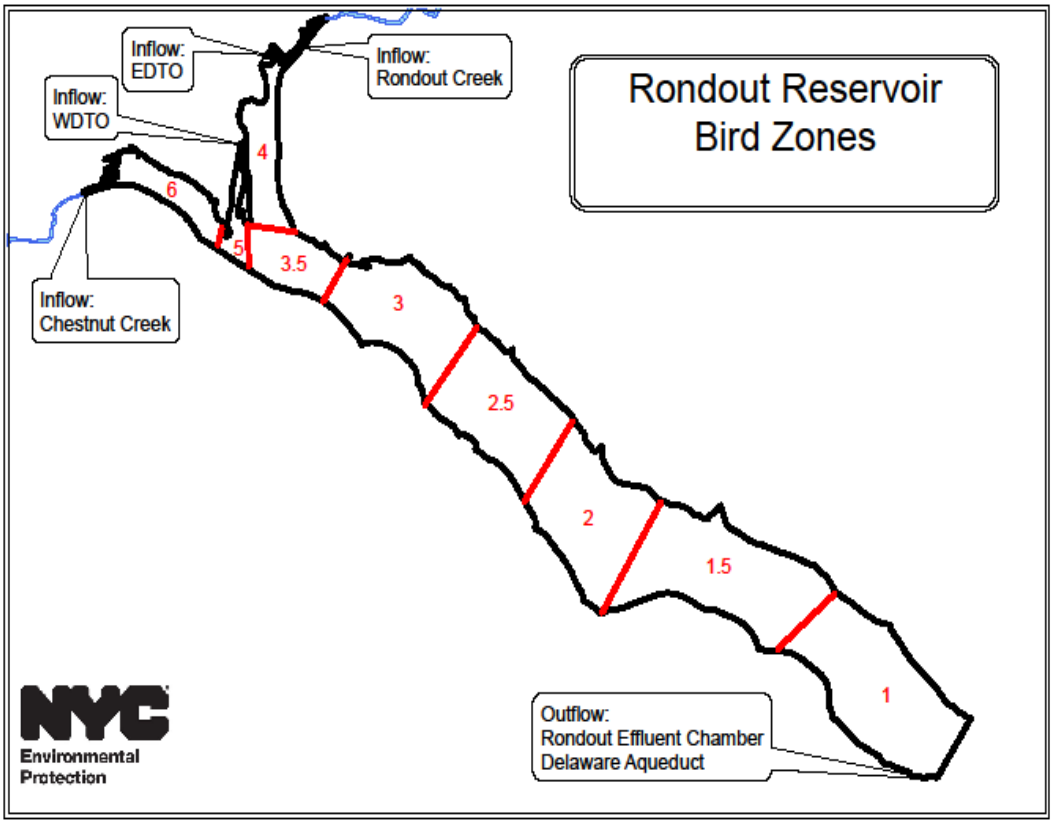


Figure 35. Map of Rondout Reservoir bird zones.

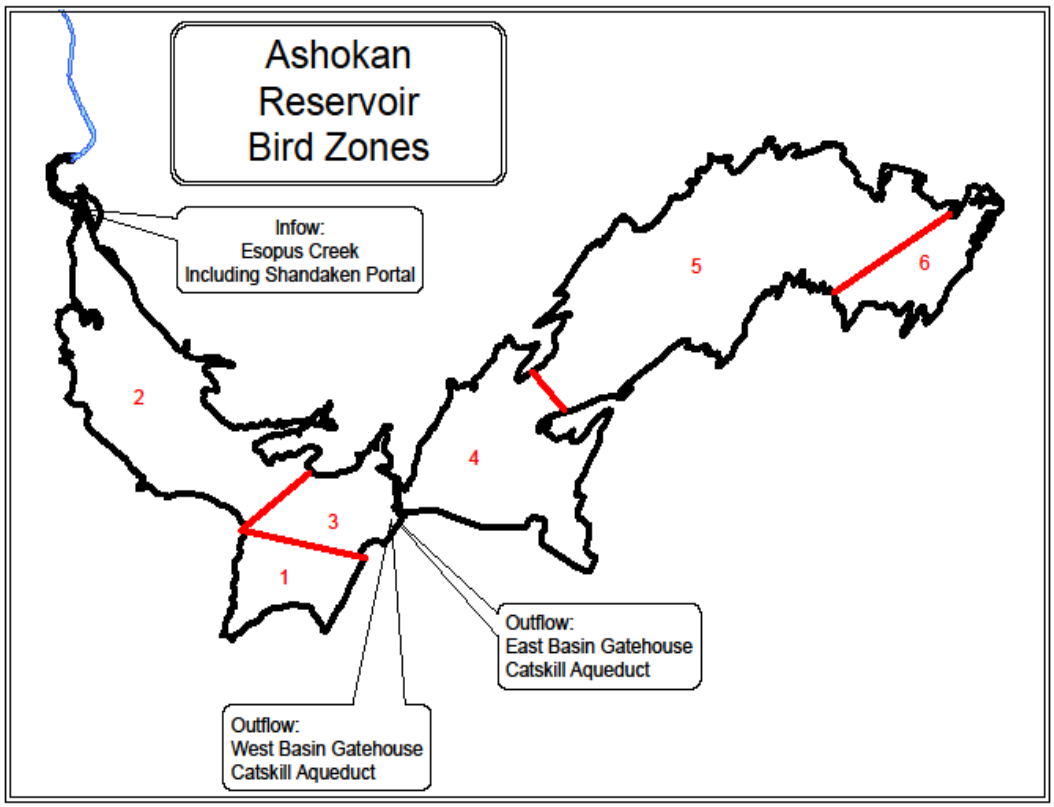


Figure 36. Map of Ashokan Reservoir bird zones.

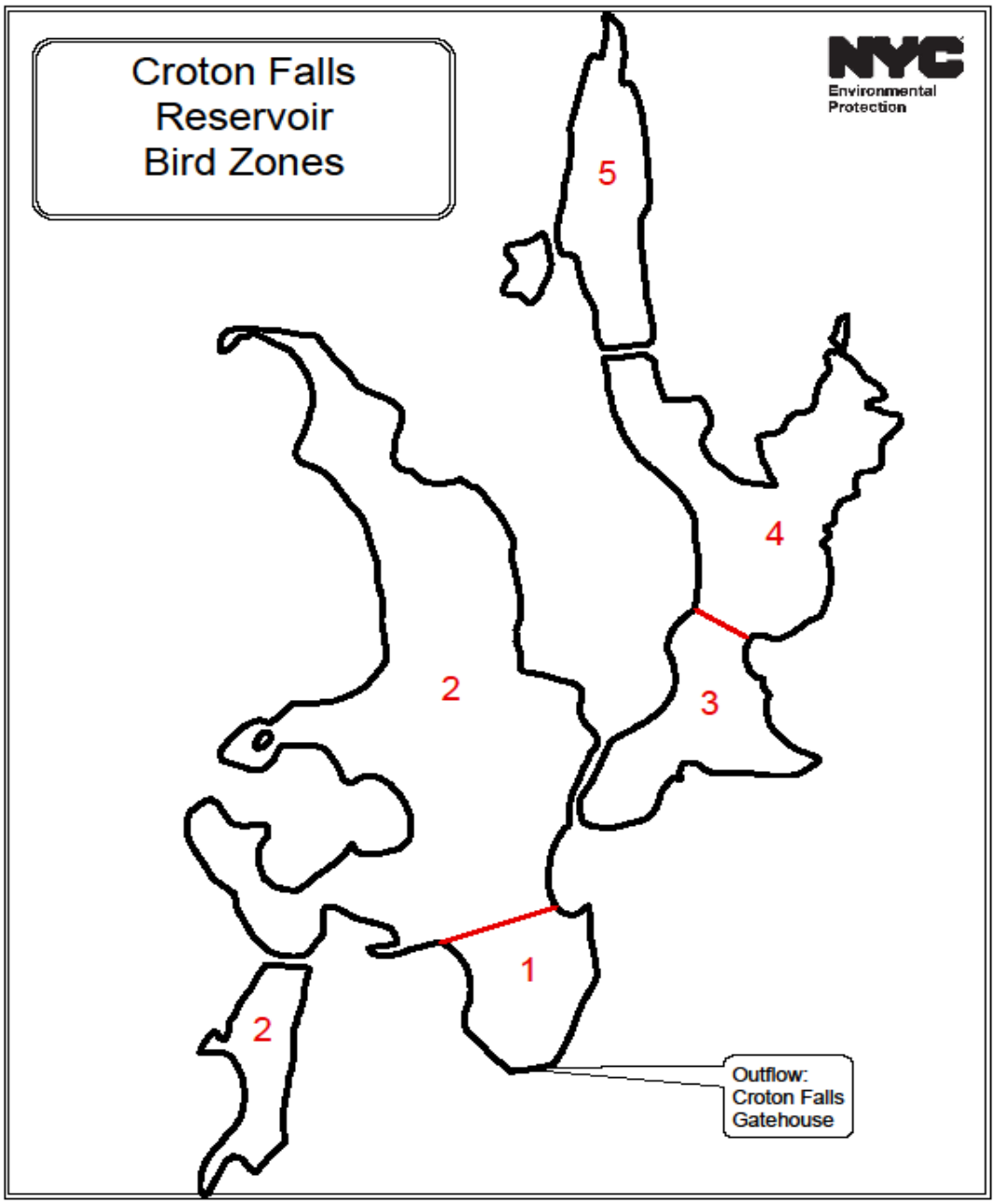


Figure 37. Map of Croton Falls Reservoir bird zones.

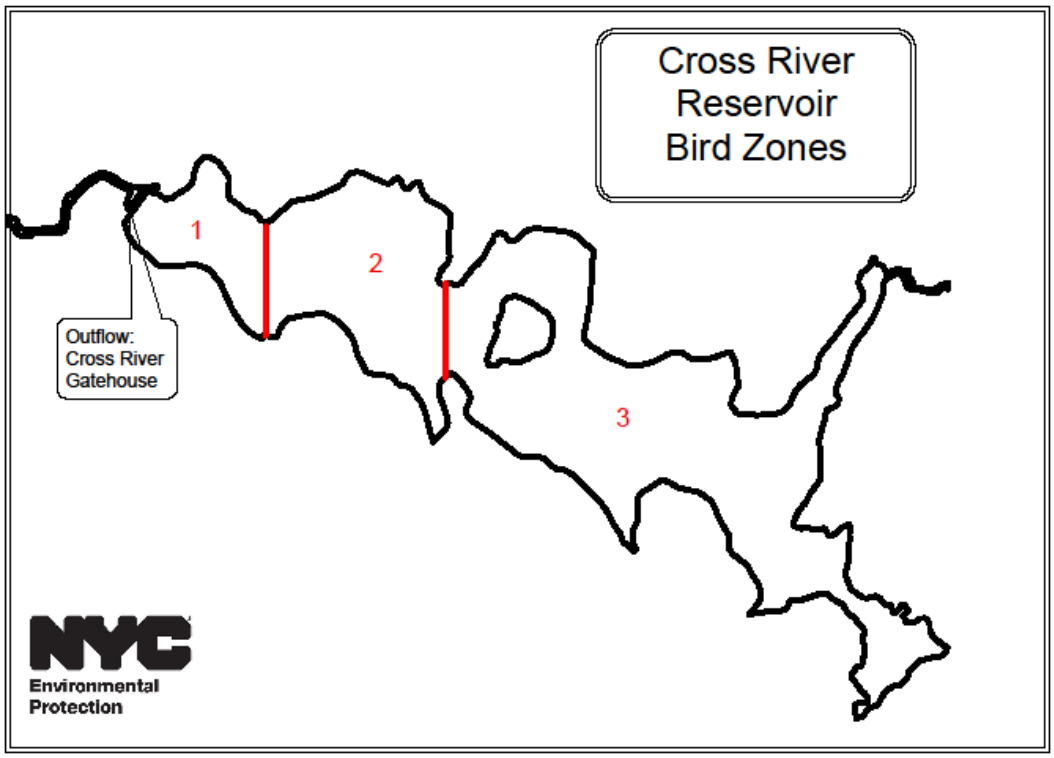


Figure 38. Map of Cross River Reservoir bird zones.

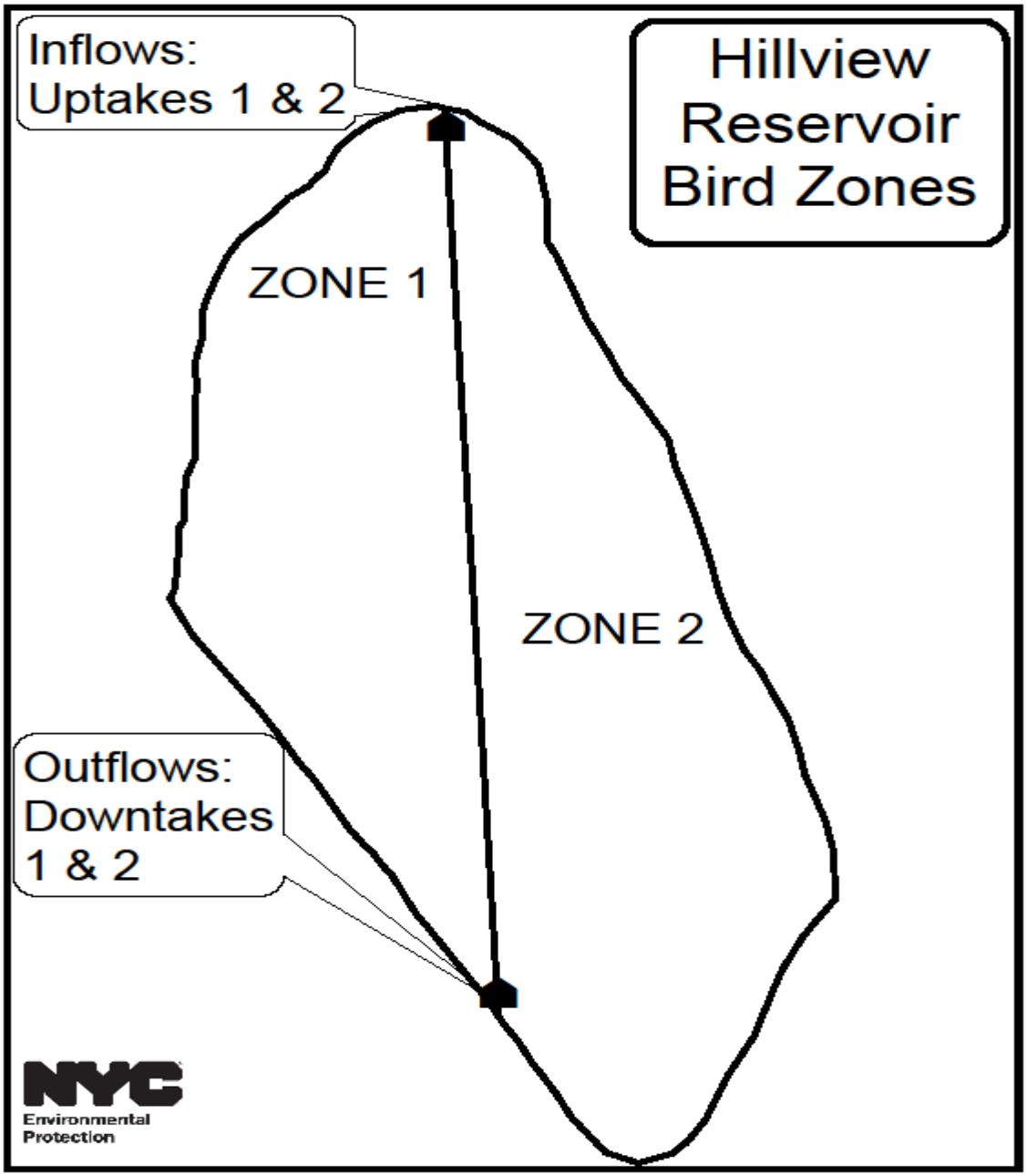


Figure 39. Map of Hillview Reservoir bird zones.

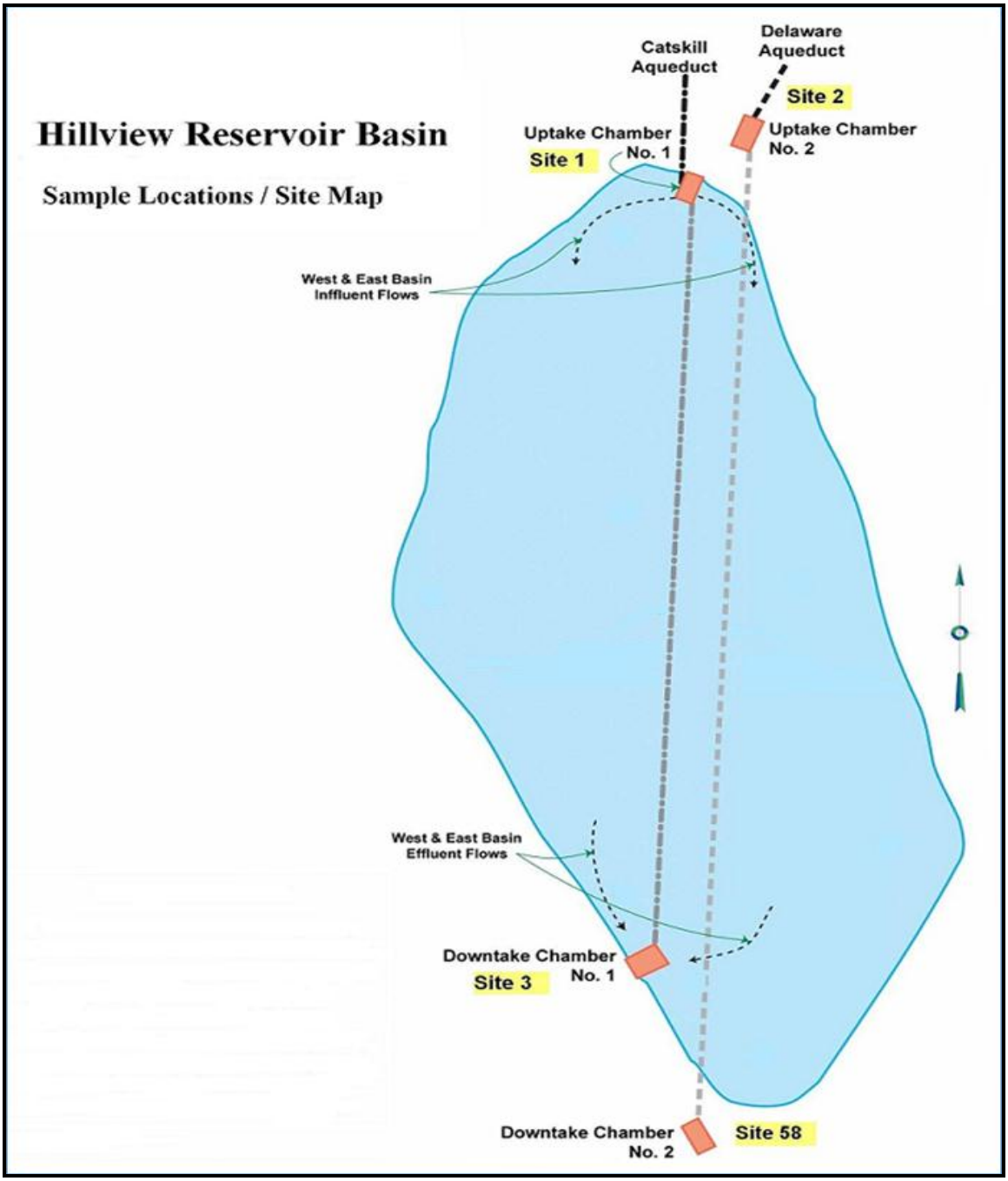


Figure 40. Map of Hillview Reservoir water sampling locations.