



# Bird Harassment Program History: 1990 - 2023

## Wachusett Reservoir



*DCR staff launch pyrotechnics to move birds from the water supply*

November 2023

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Massachusetts Department of Conservation and Recreation  
Division of Water Supply Protection  
Office of Watershed Management  
Wachusett/Sudbury Region  
Environmental Quality Section

## Summary

The Massachusetts Department of Conservation and Recreation, Division of Water Supply Protection, Office of Watershed Management manages the Wachusett Reservoir and its watershed to provide safe drinking water to the Massachusetts Water Resources Authority serving 3.1 million people in 53 communities primarily in metropolitan Boston and the MetroWest communities. The Division's Environmental Quality Section, with assistance from the Natural Resources Section, implement a comprehensive Bird Harassment Program (BHP) to minimize fecal coliform bacteria and pathogens in the water.

This document describes the federal regulatory mandates for providing safe public drinking water, the water quality problems associated with bacteria and pathogens in drinking water, the history of compliance at Wachusett Reservoir, the establishment of the Bird Harassment Program, and its early history and evolution throughout the ensuing years leading to present day successes. Also detailed are the various methods and techniques employed to refine and improve the program to successfully fulfill its goal of reducing the number of waterfowl using the reservoir and the corresponding presence of contamination to the water supply. The BHP is divided into two components: 1) actively moving birds from the North Basin of the reservoir, where the Cosgrove Intake is located, to the South Basin; and 2) reducing the bird population, primarily gulls, on the reservoir and throughout the region.

## Acknowledgments

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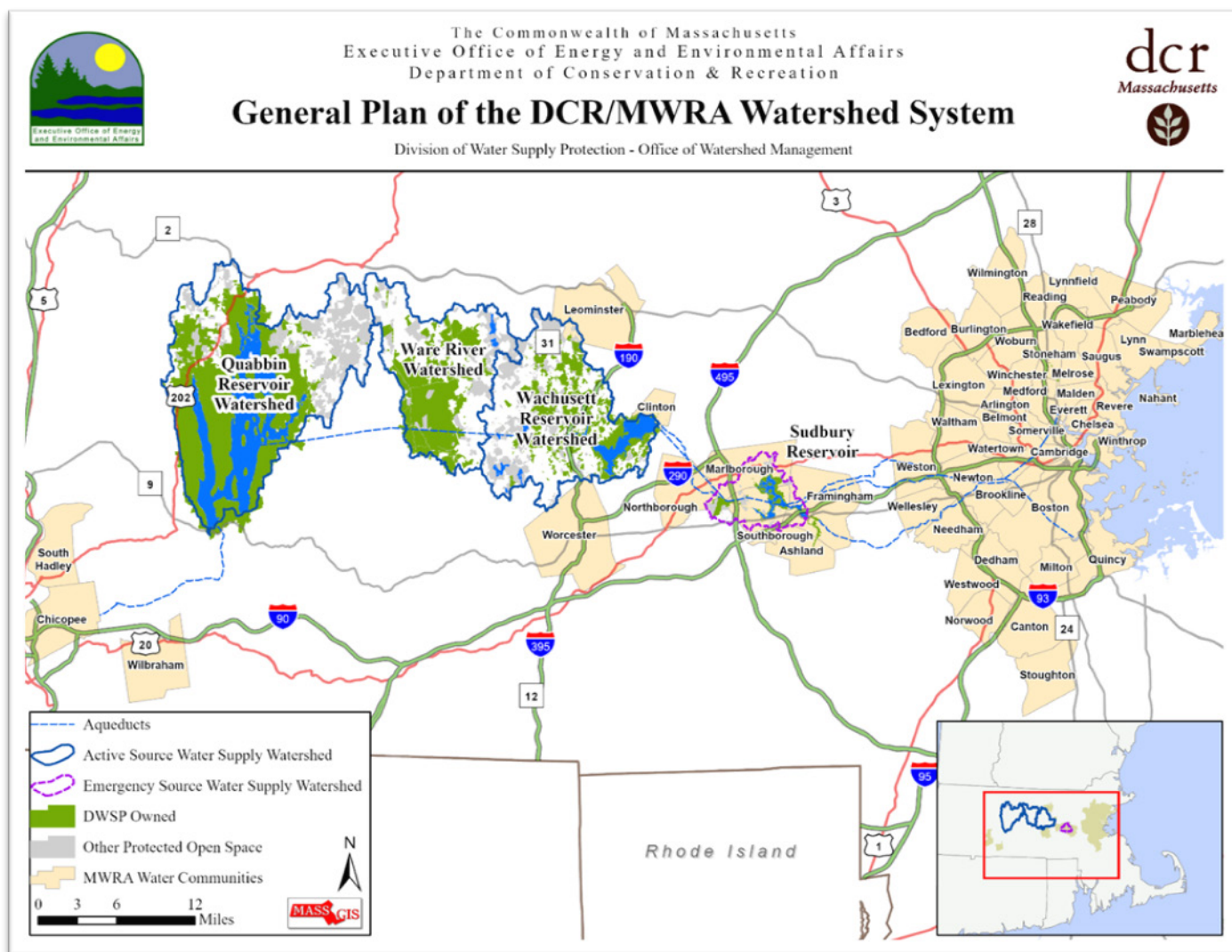
# 1 Introduction

## 1.1 Metropolitan Boston Water Supply

The public drinking water supply for metropolitan Boston is a system of watersheds and reservoirs that serves approximately 3.1 million people. The Massachusetts Department of Conservation and Recreation (DCR), Division of Water Supply Protection (DWSP), formerly the Metropolitan District Commission (MDC), manages and maintains the watersheds and reservoirs while the Massachusetts Water Resources Authority (MWRA) manages and maintains the treatment, transmission and distribution facilities.

The active watershed system includes Wachusett Reservoir, Ware River, Quabbin Reservoir and their associated watersheds, interconnected by a series of aqueducts. Sudbury watershed, containing Sudbury and Foss Reservoirs, is also part of this system, however it functions solely as emergency backup water supply.

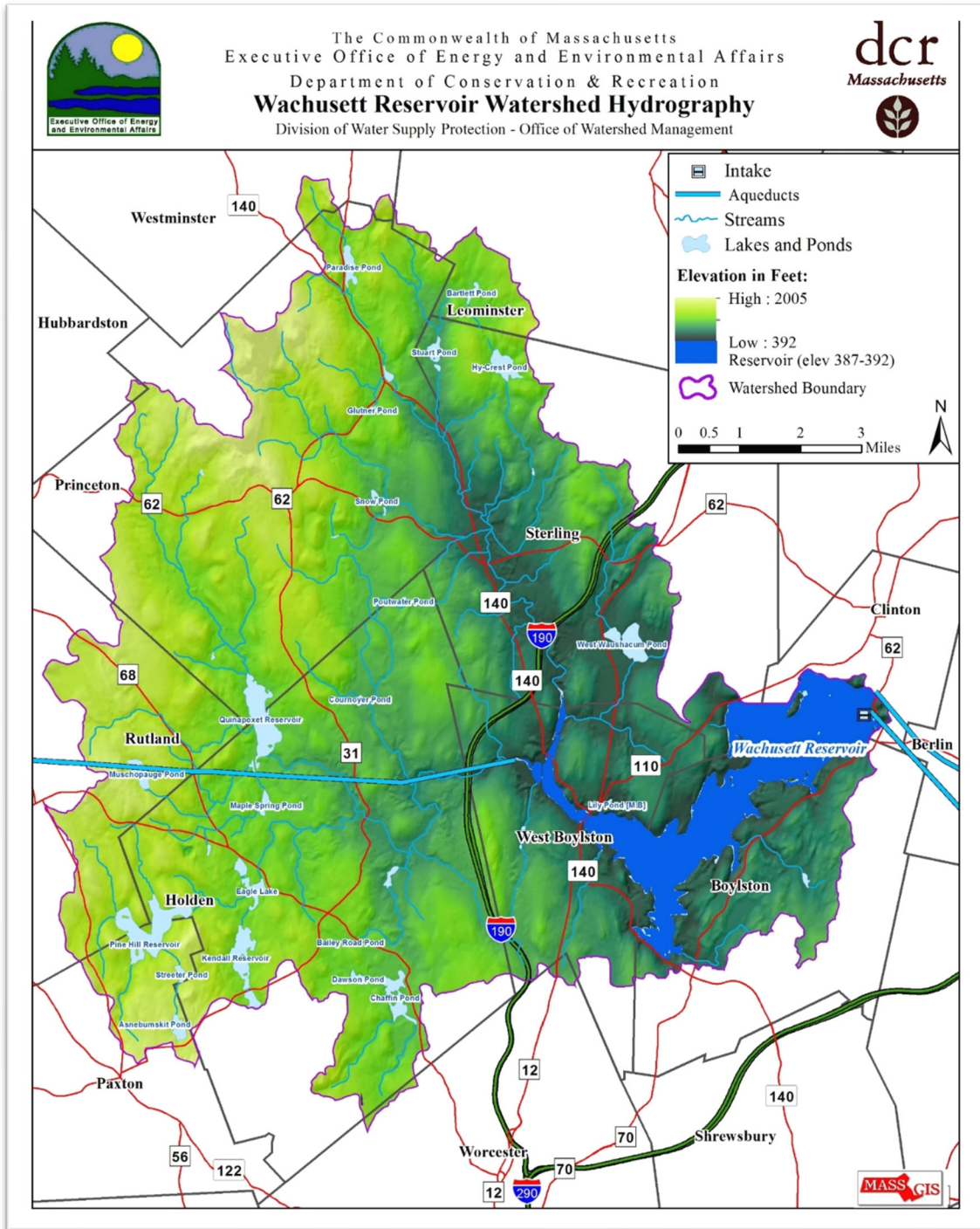
Figure 1: DCR/MWRA Watershed System



1.2 Wachusett Reservoir

The Wachusett Reservoir is located in central Massachusetts, east of the Ware River and north of the city of Worcester. Water from the Wachusett Reservoir, which has a surface area of approximately 6.5 square miles and a shoreline of 32.6 miles, is withdrawn at the Cosgrove Intake and transferred to the MWRA's John J. Carroll Water Treatment Plant in Marlborough via the Cosgrove Tunnel or Wachusett Aqueduct (presently offline). The water undergoes two primary disinfection steps, first with ozone and followed by UV light. It receives a secondary disinfection with chloramines as it leaves the treatment plant and enters the MetroWest Water Supply Tunnel and the Hultman Aqueduct. Water then enters the storage and distribution system and is ultimately delivered to greater Boston and MetroWest communities and businesses.

Figure 2: Wachusett Reservoir Watershed Hydrography





## 2 Regulatory History of Public Surface Water Supplies

### 2.1 SDWA and SWTR Mandate

The U.S. Environmental Protection Agency (EPA) introduced the Federal Surface Water Treatment Rule (SWTR) in 1989 as promulgated under the authority of the 1974 Safe Drinking Water Act (SDWA) as amended in 1986. This regulation was designed to protect public health by reducing illnesses caused by bacteria and pathogens in drinking water by requiring disinfection and, in most cases, filtration as means of treating raw water. Surface water systems had until June 1993 to provide filtration unless the DCR-MWRA-system could demonstrate by December 1991 that it met the criteria for filtration avoidance. If the water system later fell out of compliance, they were given 18 months to begin filtration (<https://www.epa.gov/dwreginfo/surface-water-treatment-rules>).

### 2.2 Filtration Avoidance

The SWTR specifies eight criteria under which filtration could be avoided. These criteria fall into two categories – Source Water Quality and Site-specific – which are targeted at total coliform bacteria, turbidity, disinfection, watershed control, on-site inspection, absence of waterborne disease outbreaks, and total trihalomethanes.

#### Regulatory Chain of Events

1986: Safe Drinking Water Act (SDWA) – *protect drinking water from bacteria and pathogens.*

1989: Surface Water Treatment Rule (SWTR) – *provide disinfection and filtration as treatment.*

- Mandate: Meet waiver criteria by 1991 or filter by 1993.
- Eight filtration waiver criteria – one is fecal coliform bacteria.
- Fecal coliform problematic at Wachusett Reservoir.

1992: Bird Harassment Program initiated to mitigate/resolve fecal coliform problem

### 2.3 Source Water Quality - Coliforms

A water supply system must meet one of the following criteria to comply with the law:

- 1.) The fecal coliform concentration in source water prior to the point of disinfection shall not exceed 20 colony-forming units (cfu) per 100-mL in at least 90% of the samples in any six-month period.

or

- 2.) Total coliform may not exceed 100 cfu per 100-mL in at least 90% of the samples in the same period.

If a system monitors for both parameters, it may exceed the total coliform limit but not the fecal limit. Fecal coliform is important as a measure of waterborne bacteria but also as an indicator of the potential presence of viruses such as *Legionella*, *Giardia lamblia*, and *Cryptosporidium*.

#### Source Water Quality Regulatory Standard

“The fecal coliform concentration shall not exceed 20 colony-forming units (cfu) per 100-mL in at least 90% of the samples in any six-month period.” These samples are taken daily.

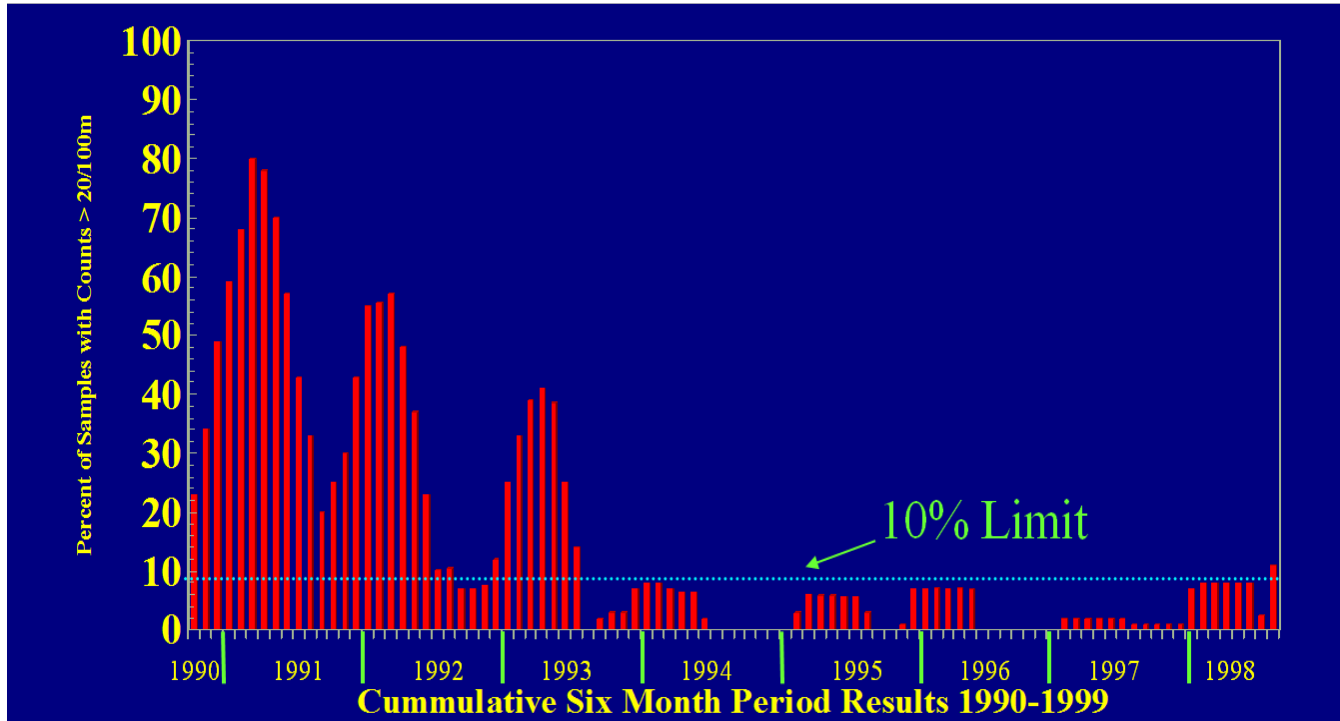
#### **OR**

No more than 10% of samples can be higher than 20 cfu/100ml in a six-month period.

## 2.4 Drinking Water Regulations and Noncompliance at Wachusett Reservoir

The 1989 SWTR required that water supplied from the Wachusett Reservoir undergo treatment by filtration to protect public health from bacteria and viruses and established water quality criteria which must be met in order to comply with the law. One of these criteria was the number of fecal coliform bacteria present in daily water samples. Historically, Wachusett Reservoir experienced elevated bacteria levels and would routinely exceed the 20 cfu/100ml limit. Seasonal patterns in these exceedances were noted to coincide with the presence of gulls on the reservoir (See: Gull Biology). These discoveries eventually lead to the creation of the Bird Harassment Program (BHP) in 1992 which substantially decreased bacteria levels, however, occasional noncompliance ultimately led to a lawsuit between the U.S. Environmental Protection Agency (EPA) and the MWRA and MDC. Legal action was initiated in 1998 and concluded in 2001 which allowed for a waiver from filtration based on several watershed protection measures, including the BHP.

Figure 3: Presence of fecal coliform bacteria prior to establishment of the Bird Harassment Program in 1992



## 3 Regulatory History of SWTR Compliance at Wachusett Reservoir

### 3.1 Seeking Filtration Waiver

Once the SWTR became effective, federal regulators in Massachusetts focused on the unfiltered Wachusett Reservoir, its history of high levels of bacteria in water samples, and its importance to the Metro Boston water supply. As an initial step towards compliance, the MWRA enlisted a consultant to determine the likelihood of the water supply system being granted a filtration waiver. The consultant concluded that the system as a whole, because of its dependence on the Wachusett Reservoir, would be unable to qualify.

### 3.2 Deadline to Meet Avoidance Criteria Passes

Samples of Wachusett Reservoir water continued to result in elevated bacteria above the threshold allowed under the SWTR. On January 24, 1992, with the passing of the December 1991 deadline for the MWRA to meet the filtration avoidance criteria, the Massachusetts Department of Environmental Protection (MassDEP) ordered the MWRA to provide filtration and disinfection treatment for the Wachusett Reservoir source water by June 30, 1993, in accordance with the provisions of the

SWTR. MassDEP's drinking water regulations, adopted on October 26, 1990, conformed to the SWTR and required filtration if a water system fails to meet one or more of the avoidance criteria.

### *3.3 Administrative Consent Order*

In early 1993, MassDEP, MWRA and MDC negotiated an Administrative Consent Order (ACO) before the June deadline, allowing the filtration waiver to continue if a watershed protection plan was fully implemented by July 31, 1997. Work was begun to design and complete a filtration facility by April 29, 1998, in the event the avoidance strategy failed. Following this "dual track" strategy, the authority to enforce the SWTR was delegated to MassDEP by EPA on June 28, 1993, two days before the SWTR deadline requiring filtration.

MassDEP approved the ACO on August 26, 1993, which included, for the time being, treatment involving filtration and ozonation. The ACO also included a clause permitting the MWRA to seek a determination by August 3, 1998, that filtration would no longer be required. EPA was supportive of this decision and on June 3, 1993, stated it will support the ACO if signed by July 1, 1993, and withhold any enforcement; the ACO was signed on June 11, 1993.

### *3.4 EPA Participation and Concern*

EPA participated in the MWRA and MDC efforts to bring the water system into compliance over the next three and a half years. In early 1997, however, EPA became concerned that deadlines involving a filtration waiver and the design and construction of the filtration plant would not be met. These concerns were expressed in multiple letters to MassDEP. In response the ACO was amended moving the date for full design to January 31, 2002, and to delay construction of the filtration facility to December 31, 2003.

In October 1997, MWRA proposed to MassDEP that it will proceed with chlorination-based treatment and ozonation as well as freezing the filtration facility design work at 60% (to maintain flexibility in case that track was not pursued). In response, MassDEP ordered the MWRA to complete the design of the ozonation/filtration plant in February 1998

On December 9, 1997, EPA informed MassDEP and MWRA that the agency has asked the Department of Justice to file an enforcement action because of the December 30, 1991, failure to meet the filtration avoidance criteria. The agency further stated that the MWRA currently did not meet the criteria and will not meet them by the August 3, 1998, deadline given in the ACO. Court action commenced on February 12, 1998. MassDEP subsequently denied the request for a filtration waiver but also extended the deadline for MWRA to submit evidence it could meet the filtration requirements until October 31, 1998.

MassDEP determined on December 22, 1998, that the MWRA's water system met the avoidance criteria of the SWTR with the caveat that if the MWRA failed to comply with any avoidance criteria the waiver will be revoked, and filtration will again be required. Despite exceeding fecal coliform thresholds in December 1998 and January 1999, MassDEP declined an EPA request that it rescind the waiver.

During this period, the litigation between the EPA and the MWRA and MDC continued to make its way through the legal system.

### *3.5 MWRA and MDC Compliance Effort*

In order to meet the SWTR mandate to provide filtration for Wachusett Reservoir water, the construction of an estimated \$180 million filtration plant would necessary (Note: this was the cost as of 1990, the current adjusted cost would be in the range of \$500 million (MWRA, pers. comm.), a facility deemed, at the time, beyond the financial ability of the MWRA and ultimately the water users. As a result, the MWRA decided the best course of action would be to pursue a waiver from filtration, which would require developing water quality programs and using technology to meet the avoidance criteria in the short- and long-term. This ultimately would consist of a combination of system upgrades and a comprehensive watershed protection plan.

During the period from 1990 to 2000, while working with MassDEP and EPA to meet the avoidance criteria, the MWRA was constructing and upgrading treatment facilities for disinfection and corrosion control systems by replacing open reservoirs

with covered storage facilities and cleaning or replacing local water distribution piping. The MDC worked towards this goal by administering the 1992 Watershed Protection Act (a regulatory framework for protecting sensitive land in the reservoir's watershed), instituting a process for acquiring land for preservation from development utilizing a \$135 million bond established by the Watershed Protection Act, constructing sewers in the two most densely populated towns in the Wachusett Reservoir watershed, establishing water quality monitoring procedures, and implementing a Bird Harassment Program. These programs were incorporated into a Watershed Protection Plan designed to assess, evaluate, and implement measures to protect the reservoir and its watershed.

### 3.6 Lawsuit: EPA v MWRA and MDC

As previously described, by 1997, after periodic exceedances of fecal coliform bacteria thresholds and the failure to meet avoidance deadlines, the EPA had become convinced that the MWRA system would never meet the avoidance criteria and a lawsuit was initiated in US District Court in 1998: *EPA v MWRA On the Best Course Forward for MWRA's Drinking Water Program*. The case named both the MWRA and MDC as defendants and continued for approximately two years until May 5, 2000, when a decision was issued in favor of the MWRA and MDC. Cited in this decision, as summarized by the MWRA, was the MWRA's comprehensive approach whereby the judge "evaluated Wachusett water quality in the context of the historic design of the system, the accomplishment made in watershed protection through land use control and acquisition, construction of sewers, and **gull harassment** (emphasis added), the role of distribution system improvements including covered storage and pipeline rehabilitation, and recent treatment enhancements." In all, the judge listed 35 reasons in favor of filtration avoidance. Point 1(C) from "XI *Ultimate Conclusions of Fact and Law*" of the decision specifically cites "the full implementation of the **gull harassment program**" (emphasis added) as one of these reasons and a description of the program is summarized in the "MDC Management Practices Within the Watershed" section as one of the important watershed protection programs.

For complete information on the full court decision, a summary and day by day account of the trial see: [Filtration Full Court Decision](#) and [Filtration Decision Summary](#) available on MWRA's website.

One year later in 2001, the District Court decision was upheld on Appeal in *US EPA v MWRA and MDC on Appeal from the US District Court* which cited in its decision "In rendering this judgment, the court was careful to shape its decision so as to ensure that the MWRA's drinking water will meet the avoidance-criteria standards that are the EPA's benchmarks for safety. The court decision did allow for revisiting the decision in the event of non-compliance in the future. For more information see [Filtration Appeal Summary](#) and [Filtration Decision Appeal](#).

Since this time, Annual Filtration Avoidance inspections of the reservoir and watershed protection programs by MassDEP have continued to approve the Waiver.

#### Figure 4: Regulatory Timeline

- **1989:** Filter by June 1993 unless meet criteria for waiver by December 30, 1991.
- **1992:** January – Deadline passes. MassDEP orders filtration by June 30, 1993.
- **1993:**
  - MassDEP agreement allows waiver if watershed protection plan fully implemented by July 31, 1997, and filtration facility designed by April 29, 1998.
  - EPA supportive if agreement signed by July 1; agreement signed.
- **1997:**
  - Early in year – MassDEP amends agreement moving the date for filtration facility design to January 31, 2002, and to delay construction of facility to December 31, 2003.
  - October – MWRA proposes to MassDEP to begin chlorination-based treatment with ozonation and freeze facility design work at 60%. MassDEP orders complete design of the ozonation/filtration plant by February 1998.
  - December 9 – EPA initiates enforcement action because of the December 30, 1991, failure to meet the filtration avoidance criteria.
- **1998:**
  - February 12 – MassDEP denies filtration waiver but extends deadline for evidence that meets filtration to October 31.
  - February 12 – Lawsuit begins, *EPA v MWRA On the Best Course Forward for MWRA's Drinking Water Program*.
  - December 22 – MassDEP determines that water system meets the avoidance criteria.
  - December and January 1999 – Bacteria exceedances. MassDEP declined an EPA request that it rescind the waiver.
- **2000:** May 5 – Decision issued in favor of MWRA and MDC. **Gull Harassment Program** cited as one reason in support of a filtration waiver.
- **2001:** July 16 – Decision upheld on Appeal.
- **2001 - present:** Annual Filtration Avoidance watershed inspections by MassDEP continue to approve Waiver

### 3.7 Birds and Bacteria

The main contributor to elevated bacteria in the reservoir was eventually linked to the presence of birds (gulls, geese, ducks, and cormorants) utilizing it as an overnight roosting site as well as a breeding location. Gulls comprised the vast majority of these birds. In response, a program of harassment and population reduction was developed to reduce or eliminate the bird population and keep them away from sensitive areas. This program continues to this day, successfully reducing fecal coliform bacteria counts in the water to maintain regulatory compliance. It is one of several programs that have allowed the MWRA to avoid the immense cost of building and operating a filtration facility.

## 4 Gull Biology

### 4.1 Gulls in New England

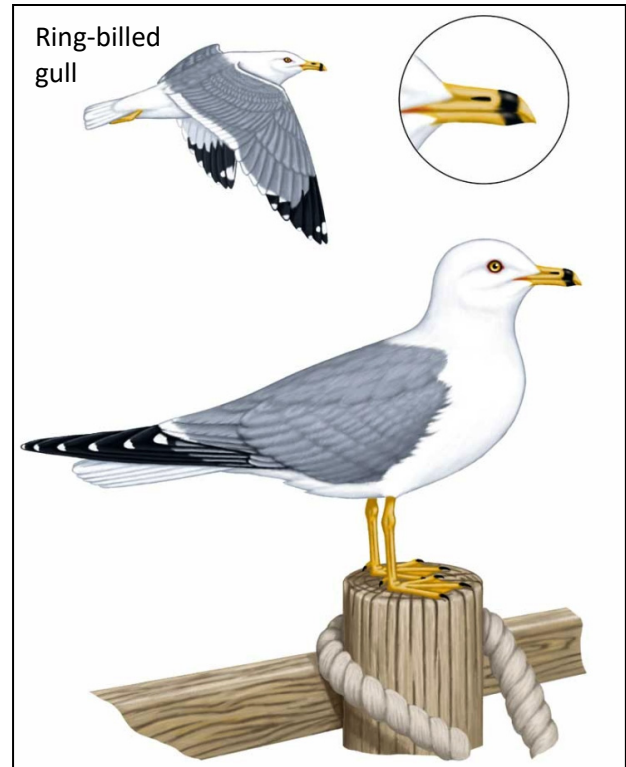
#### Ring-billed gull

The Ring-billed gull (*Larus delawarensis*) is the smallest of the three common gulls on the reservoirs. It is characterized by a black circle around the tip of its yellow bill. They are typically 17-21 inches in length with a wingspan of 41-46 inches. Adults weigh between 300-700 grams.

Ring-billed gulls are extremely adept at finding and exploiting food resources. They are commonly found in parking lots near malls, restaurants, and department stores where garbage or hand-outs are readily available. In addition, ring-billed gulls can be seen in large recreational fields feeding on worms, agricultural fields after plowing, near waste-water treatment plants, and in landfills. Ring-billed gulls have also been documented using obscure, temporary feeding sites such as piles of expired bread at pig farms and large composting facilities.

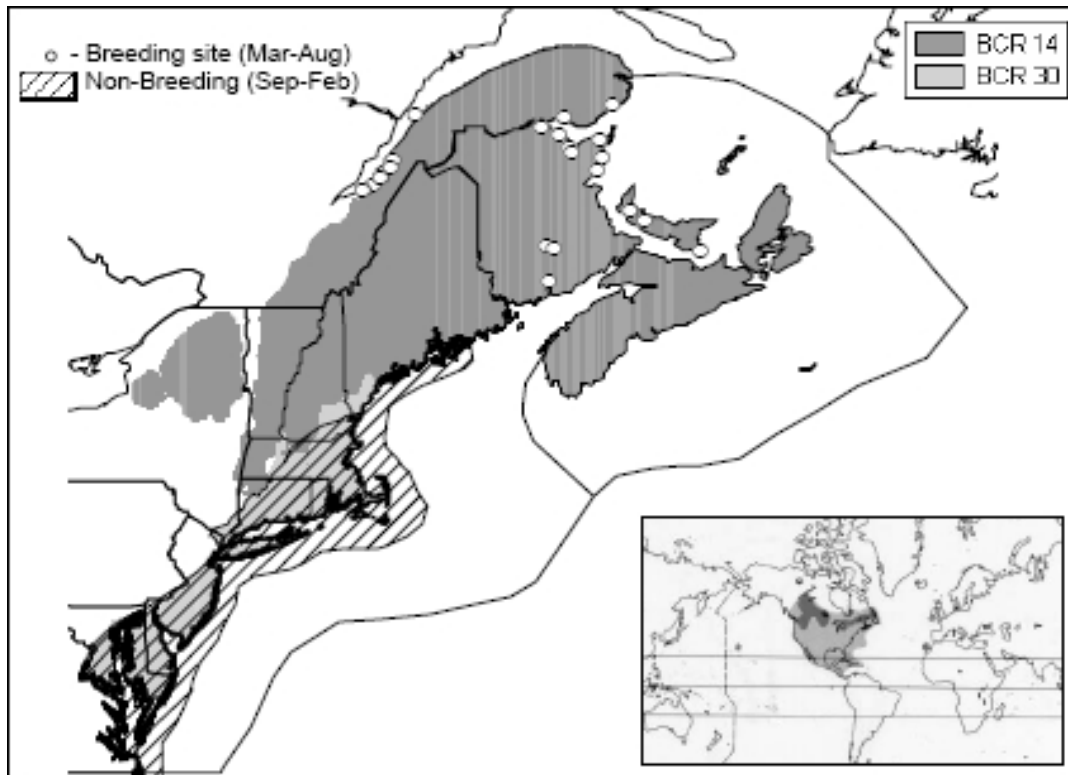
Ring-billed gulls are predominately inland nesters. There are currently no known nesting sites in Massachusetts. A small colony (<20 pairs) attempted to establish a nesting colony on an island at Wachusett Reservoir during the summer of 1997. Approximately 10 nests with 16 eggs were discovered on Cunningham Ledge. The colony was quickly controlled, and no further nesting attempts were made. Currently, most breeding occurs in the northern maritime provinces of Canada, the Great Lakes, and Lake Champlain.

Regional populations of ring-billed gulls have increased since 1976 (MANEM 2006). Maine recently documented two inland nesting sites, one at Lake Umbagog and a second on Long Lake in Arostook County.



During the 1990s, an estimated 41,000 breeding pairs were present in Canada. Greenlaw and Sheehan (2003) provide a more detailed description of ring-billed breeding in the Northeast.

*Figure 5: Regional distribution of breeding and non-breeding Ring-bill gulls*



## Herring gull



The Herring gull (*Larus argentatus*) is the gull often associated with the ocean and the beach. It is a medium to large gull with a yellow bill that has a red dot near the tip on the lower mandible. The wing tips are black with white spots. Herring gulls are 22-26 inches long, with a wingspan of 54-57 inches. They weigh between 800 and 1250 grams.

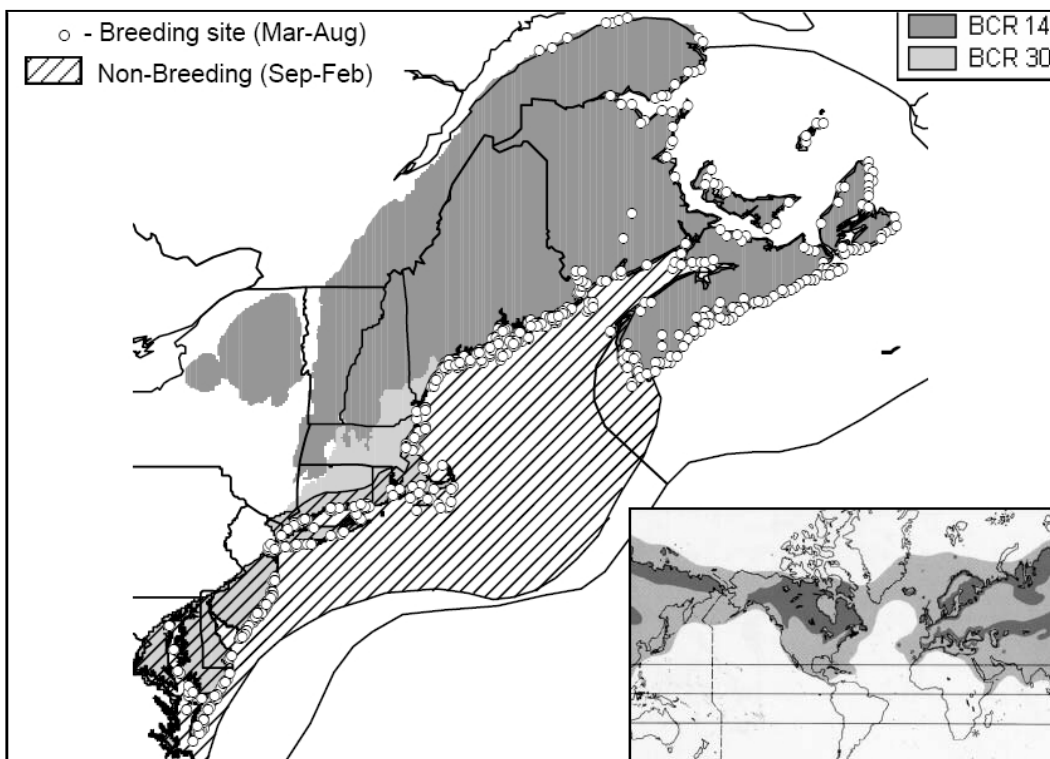
Herring gulls can be found feeding along beaches and mudflats, in association with fishing boats, and inland at landfills, sewage treatment plants, and occasionally in parking lots. Herring gulls are one of the most common gulls found at inland landfills.

Historically, herring gulls only nested along the coast on islands with rocky or sandy substrate. They have expanded their nesting range and now also nest inland on roof tops, lakes, rivers and reservoirs. In Massachusetts, the only confirmed inland nesting site was on Wachusett Reservoir in the 1960s. Breeding was first detected in 1965, when 800 adults and 30 flightless young were found (Petersen and Meservey 2003). The reservoir colony reached its maximum in 1967 with 500 pairs. Beginning in 1967, the Metropolitan District Commission began a gull control program to remove eggs and nests. It proved effective, and no herring gull has nested on the reservoir since 1997.

Regional populations of herring gulls declined during the 1990s.

There was a 19% decrease in regional populations in the U.S., and populations in Canada also declined (MANEM 2006). Declines were attributed to disturbance and predation at nesting sites, competition from great black-back gulls, and reduction in food supply (Mid-Atlantic waterbirds).

Figure 6 : Regional distribution of breeding and non-breeding Herring gulls



### Great black-backed gull

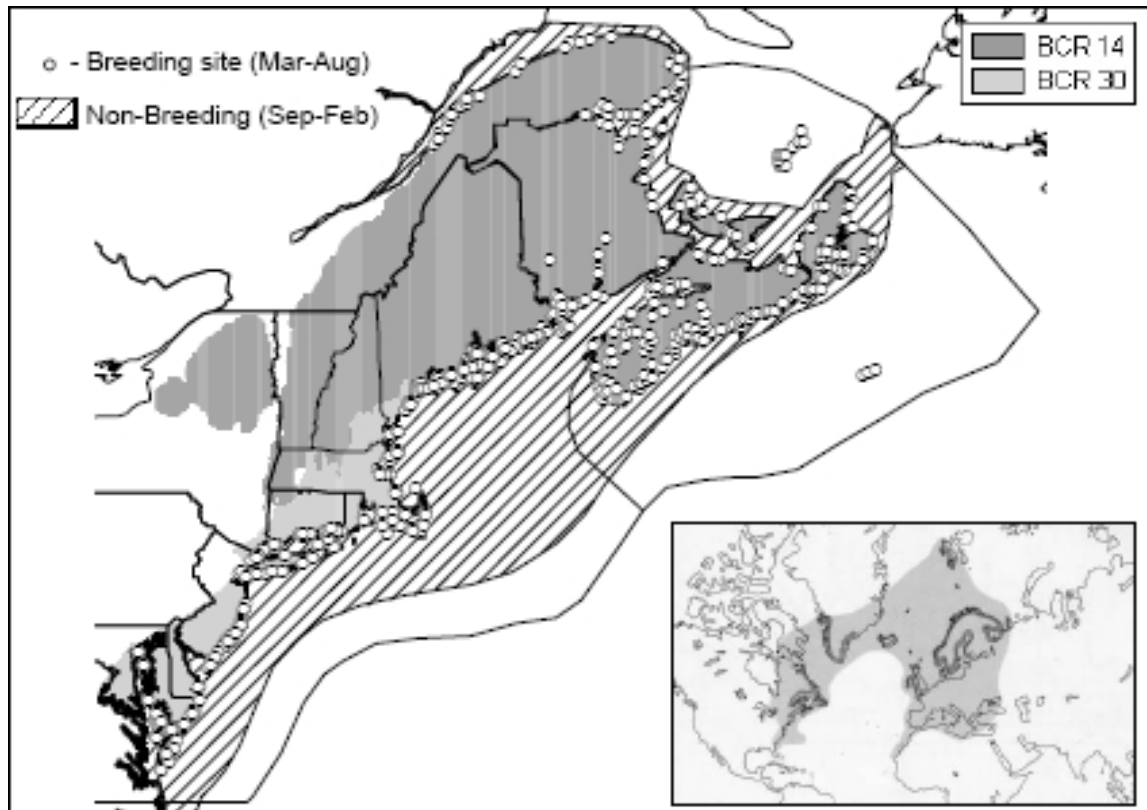
The Great black-backed gull (*Larus marinus*) is the largest gull in the world. Although historically only found along the coast and at sea, today they can be seen inland foraging and breeding. It is a large bird with a pure white breast and belly. Its wings and back are a dark sooty black. Black-backed gulls are 28-31 inches long, with a wingspan of 57-63 inches. They weigh between 1,300 and 2,000 grams.

The Great black-backed has been expanding its historical range southward since the turn of the century. In the 1920s Nova Scotia was the southern limit. By 1931, they made it to Massachusetts where they were found nesting in Salem. There are several current breeding sites in Massachusetts, all along the coast. Historical records indicate that they nested inland at Wachusett Reservoir, probably associated with the Herring colony during the 1960s (Peterson and Meservey 2003). There are no recent records of inland nesting by this species.

Regional populations of Great black-backed gulls have increased dramatically. From the 1970s to the 1990s, populations increased 109% (MANEM 2006). Great black-backed gulls are aggressive to other gulls and other colonial nesting birds (terns, puffins). They will often displace herring gulls when both species are nesting in the same area.



Figure 7: Regional distribution of breeding and non-breeding Great black-back gulls





## 4.2 Gulls at Wachusett Reservoir

Ring-billed gulls are the most common species seen inland in Massachusetts. Gulls have been utilizing Wachusett Reservoir since at least the 1960s when large groups were observed moving back and forth between the reservoir and adjacent landfills in Clinton and West Boylston (B. Blodgett, pers. Comm.). As the second largest body of water in Massachusetts, it is likely that some population of gulls have always used the reservoir to roost at night and for a daytime loafing area. Regional gull populations have fluctuated over the years and are influenced greatly by the availability of food and reproductive success at the nesting colonies. In addition, urbanization in Massachusetts over the last 40 years has led to an increase in food sources for ring-billed (and herring) gulls. Gulls are highly adaptable and can exploit novel food sources including landfills, sewage treatment plants, agricultural operations, and handouts from humans in large commercial parking lots.

Gulls are found on Wachusett Reservoir year-round; numbers are lowest during the summer months. Most gulls seen during the summer are immature or non-breeding adult Ring-billed gulls. During late summer and early fall, adult birds return from the breeding grounds and begin feeding at various locations in central Massachusetts. Many of the ring-billed gulls foraging near Wachusett Reservoir will fly to the reservoir each night to roost. However, alternative roost sites do exist. Gulls have been documented roosting on Sudbury Reservoir, Lake Quinsigamond, Indian Lake, and Norumbega (pers. obs.).

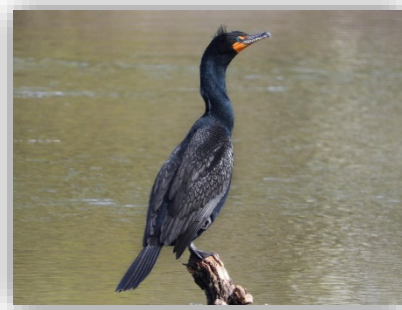
During the early fall, the nightly Wachusett roost is primarily comprised of immature and adult ring-billed gulls. Totals may reach 2,000 birds. Very few herring gulls and no black-back gulls roost on the reservoir during the fall. During late fall into winter, the number of roosting gulls begins to increase. A large reason for the increase is the addition of herring and black-back gulls. As ice begins to form on smaller lakes and ponds, herring and black-back gulls are forced to find alternate roost sites that are ice free. Because of their size, Wachusett and Quabbin reservoirs are typically the last bodies of water to freeze (if at all – with climate change, annual full reservoir ice-over is becoming less common in winter). During winter, the number of roosting gulls may reach 6,000 birds per night. Of these 6,000 gulls, several thousand may be herring and up to 1,000 may be black-back.

If conditions allow the reservoirs to freeze completely, gulls discontinue using the reservoir and probably roost on the coastline or fly further south to open fresh water. After spring ice-out, gull numbers can increase again briefly. Typically, by mid to late spring, most adult gulls have begun moving towards the breeding grounds where they will spend the summer. Also, alternate roost sites are again ice free and probably begin attracting roosting gulls.

Daily use of the reservoir also follows a pattern where the gulls feed regionally throughout the day, then return in the late afternoon and early evening to roost on the water where they feel safe from predators. Some birds will remain at the reservoir throughout the day loafing and feeding, but the majority leave at sunrise.

## 4.3 Other Species

While most birds using the reservoir are gulls, other species such as Canada Geese (*Branta canadensis*), Double Crested Cormorants (*Phalacrocrax auritas*), and a variety of ducks use it as well. All are present in much lower numbers, with geese being the most abundant. Geese and ducks follow a similar seasonal pattern as gulls while cormorants are present in consistent numbers until they depart at the onset of cold weather. While these birds are not feeding from the same sources as gulls – geese feed on grass and other vegetation and cormorants primarily eat fish – their excrement still poses a water quality threat.



*Double Crested Cormorant*

The reservoir is appealing to gulls for several reasons. Physical conditions are amenable to bird roosting given the large area of open water (approximately 6.5 square miles), there are shallow areas, exposed rocks to loaf on, minimal human activity, and the reservoir is one of the last water bodies to freeze.

Gulls seem to prefer the northern portion of the reservoir over the southern or middle parts. It is not certain why, but speculation is that it has something to do with the direction in which they arrive, the shape of the north part of the reservoir, and the “safety in numbers” that they seek. Most flight patterns follow two directions, from the north or south, with both likely originating at urban areas with the numerous sources of food that they offer (Worcester to the south and Leominster and Fitchburg to the north). Since gulls are found in both north and south basins during the late afternoon and early evening, it may be that they land in the first area of open water they see, with gulls at the south gradually moving north as night falls and the open water there becomes more appealing. The circular shape of the north provides more open area away from the shoreline, thus congregating there they feel safer and further from predators. Harassment appears to be the main driver in moving them from north to south.

## 5 Birds and Bacteria

The MDC and MWRA concluded in 1991 that roosting gulls and other birds were the source of seasonally high fecal coliform concentrations detected in water samples taken at the Cosgrove Intake. The problem and its cause are documented in a January 22, 1991, report entitled “Status Report on Wachusett Gull Situation” by MDC Wildlife Biologist Paul Lyons. This report is the earliest official documentation of the increased gull presence and the water quality threat it posed to the reservoir.

Important conclusions:

- Gull populations have expanded as they adapted to new sources of food away from the coast (i.e., landfills, sewage treatment facilities and commercial parking lots).
- Prior to 1991, large numbers of gulls have been using Wachusett Reservoir as a nighttime roost particularly on the water adjacent to the Cosgrove Intake, a large open water area and usually the last place on the reservoir to freeze. In 1990 weekly counts recorded up to 9,000 gulls roosting on the water.
- Other birds such as geese and ducks may pose a problem but are present in fewer numbers than gulls.
- During the time birds are roosting on the reservoir, bacteria and potentially viruses are released through feces directly into the water, on shorelines, and in winter, on ice cover.
- There is a seasonal pattern where the presence of gulls increases from late summer to winter (Figure 8).
- As the population of gulls increases the presence of fecal coliform increases as shown from gull counts taken at the reservoir from September 1990 to January 1991 (Figure 9).
- Nightly roosting behavior involves several roosts. Roost locations were identified and divided into two types, minor at the South Basin and major at the North Basin. Observations of roost use revealed that birds eventually ended the day in the major ones which were the closest to Cosgrove Intake. Minor roosts were usually used as preliminary gathering areas for gulls arriving at darkness from daily feeding before moving to the more open areas of major roosts. This means birds move closer to the intake towards nightfall (Figure 10).

Figure 8: Wachusett Gull Numbers, 1990-1991

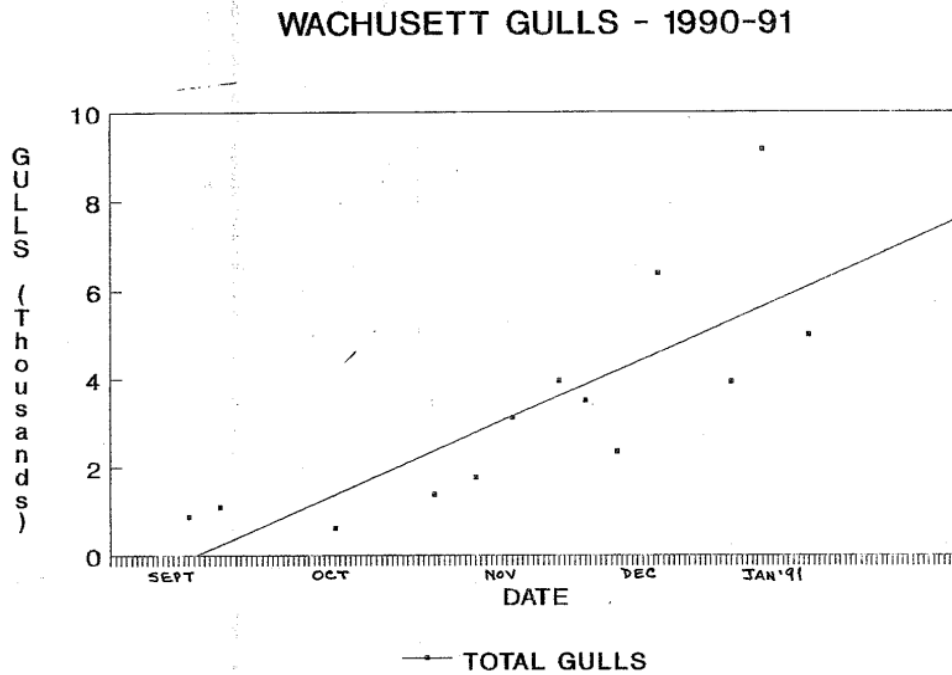


Figure 9: Wachusett Gull Numbers and Bacteria Count, 1990-1991

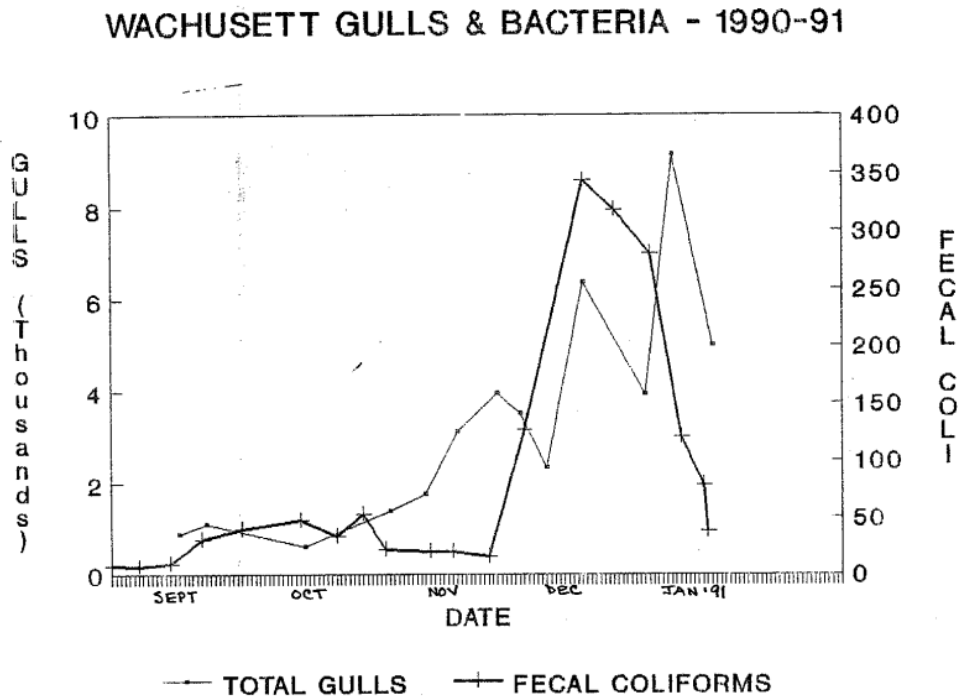
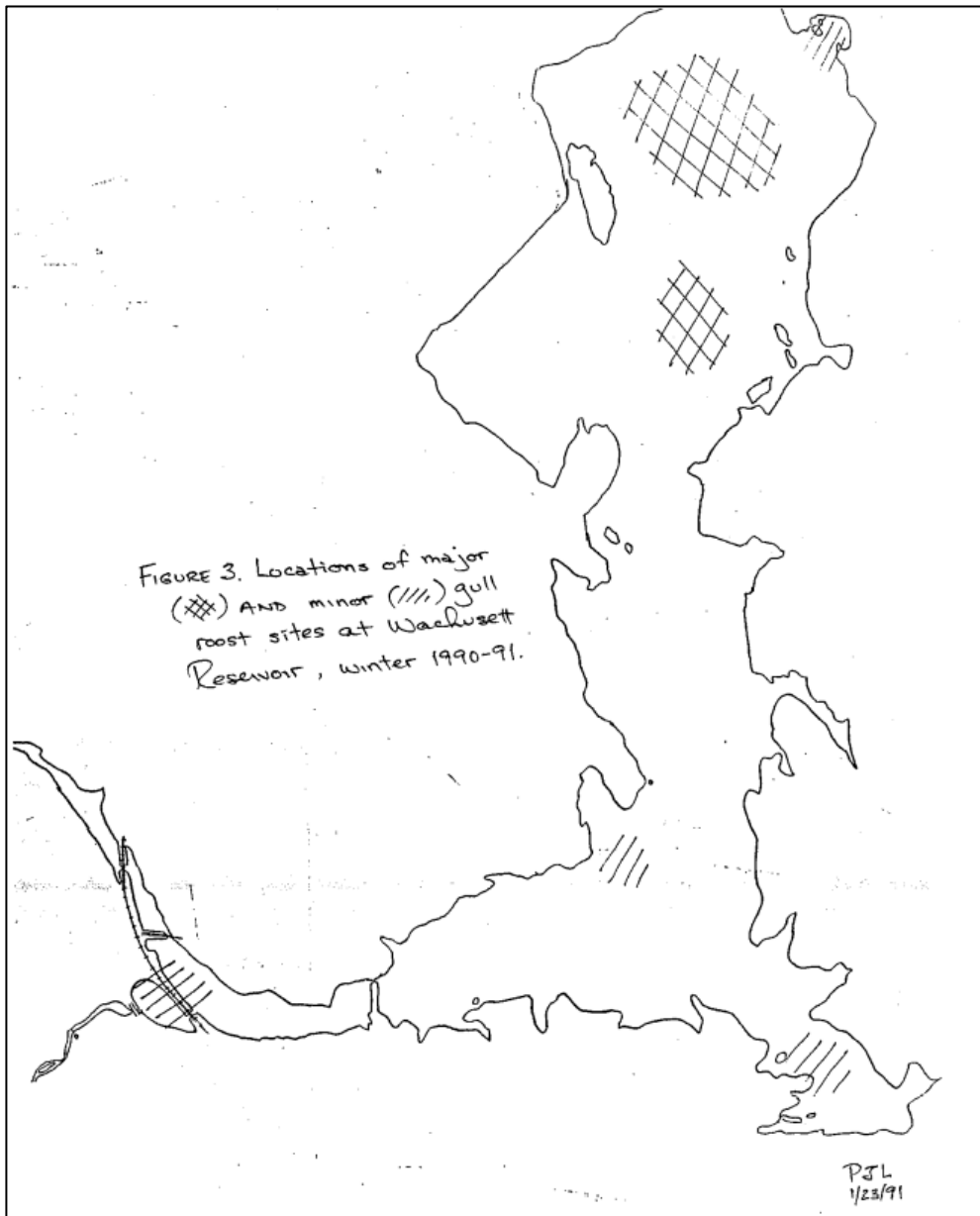


Figure 10: Location of Major and Minor Gull Roost Sites at Wachusett Reservoir, 1990-1991



Recommendations for a bird control program:

- A control program should be carefully constructed to reflect the nature of gulls which are aggressive, adaptable, and opportunistic, and a combination of strategies is necessary.
- Methods of control should fall into two main categories: population reduction and behavior modification.
- Population reduction includes shooting, use of pesticides, nest/egg destruction, and elimination of food supplies.
- Behavioral modification means creating conditions that would motivate birds to move away from sensitive areas such as the Cosgrove Intake.
- Reducing/eliminating food supplies should focus on landfills, sewage treatment plants, commercial parking lots, and other facilities where garbage or surplus food is available. This would require coordination with MassDEP, private landfill and sewage treatment operators, and commercial property owners.

- Changing roosting behavior by motivating birds to leave sensitive areas appears possible. Many harassment tools already exist such as commercially available devices using visual, auditory, and physical means or a combination of any of the three. Visual devices imitate predators like hawks and coyotes or disturb birds such as with a strobe light. Audio methods include electronically created or recorded sounds of birds in distress. Shotgun blasts, propane exploders, and pyrotechnics are also options. Physical barriers exclude birds from a targeted area such as stringing steel wire or monofilament over it.
- Moving birds would require alternative roosting sites and the reservoir appears to be large enough that birds would find one.
- Additional study likely necessary to determine how far away birds should be moved to reduce/eliminate contamination.
- A complete elimination of birds from the reservoir might be necessary.
- Reservoir management practices which might negatively affect a control program such as low water conditions exposing more shoreline and water transfers from Quabbin should be evaluated.
- Collect and analyze data on water quality and gull numbers, as well as wind and wave action, roost locations, and tributary water quality. Results should be documented to evaluate effectiveness and aid in making program adjustments.

## 6 Bacteria Distribution Survey

### 6.1 *Transect Sampling*

The MDC developed and initiated an extensive surface water sampling program in 1991 after roosting birds were identified as the cause of high bacteria counts in samples taken at Cosgrove Intake. The goal of the survey was to document the relationship between the levels of bacteria throughout the reservoir and the seasonal variations in the population of gulls and geese under a variety of natural and operational conditions. This would also determine the key locations where bacteria levels were the highest.

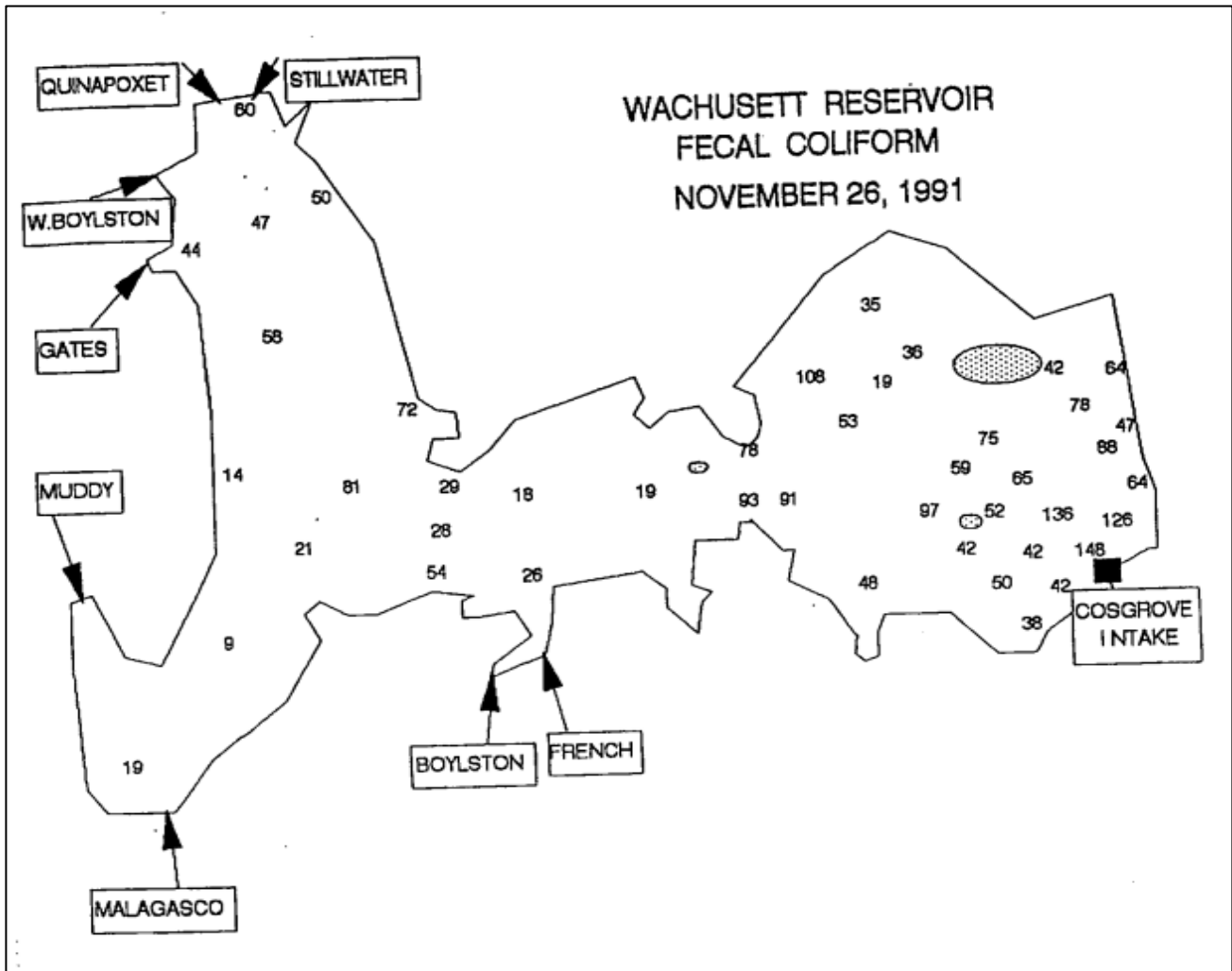
The survey consisted of dividing the reservoir surface into a grid like pattern and designating 47 sample points. The grid was based on the reservoir configuration, flow paths, and areas where birds were known to frequent. Sample locations were identified using islands and landmarks on shore and a written description (this work was performed prior to the availability of GPS technology). Samples were taken at the surface and analyzed for fecal coliform bacteria at an MDC facility by EQ staff and later by MWRA staff at the MWRA lab in Southborough.

Several modifications to the survey were considered but never adopted such as analyzing the fecal coliform for human versus nonhuman origins, using a current meter to measure flow velocities at sample sites and using two or three boats to collect all samples at a time proximate to each other.

Sampling was planned for various times throughout the year, starting in April when the reservoir is at capacity and not undergoing a transfer of water from Quabbin. The next sample sets would be taken after reservoir stratification (when water in the reservoir separates into distinct, temperature-based zones at different depths) around the middle of May, July, and August. These would be followed by samples sometime in late September to mid-October during the fall overturn (when the reservoir water stratification ends). The last sampling was scheduled for November before the cold weather would likely prevent the use of boats. Additionally, bird counts would be taken around the reservoir the day prior to the “transect sampling” (as it came to be known) by an MDC wildlife biologist to provide accompanying data on bird locations relative to the number of bacteria present in the samples.

Samples were taken that year on six occasions: May 2, May 9, September 16, October 9, October 21, and November 26. As expected, results showed that bacteria levels increased at the North Basin as the season progressed, along with a corresponding increase in bird numbers. Additionally, the highest numbers were located in the area within close proximity to the Cosgrove Intake (Figure 11).

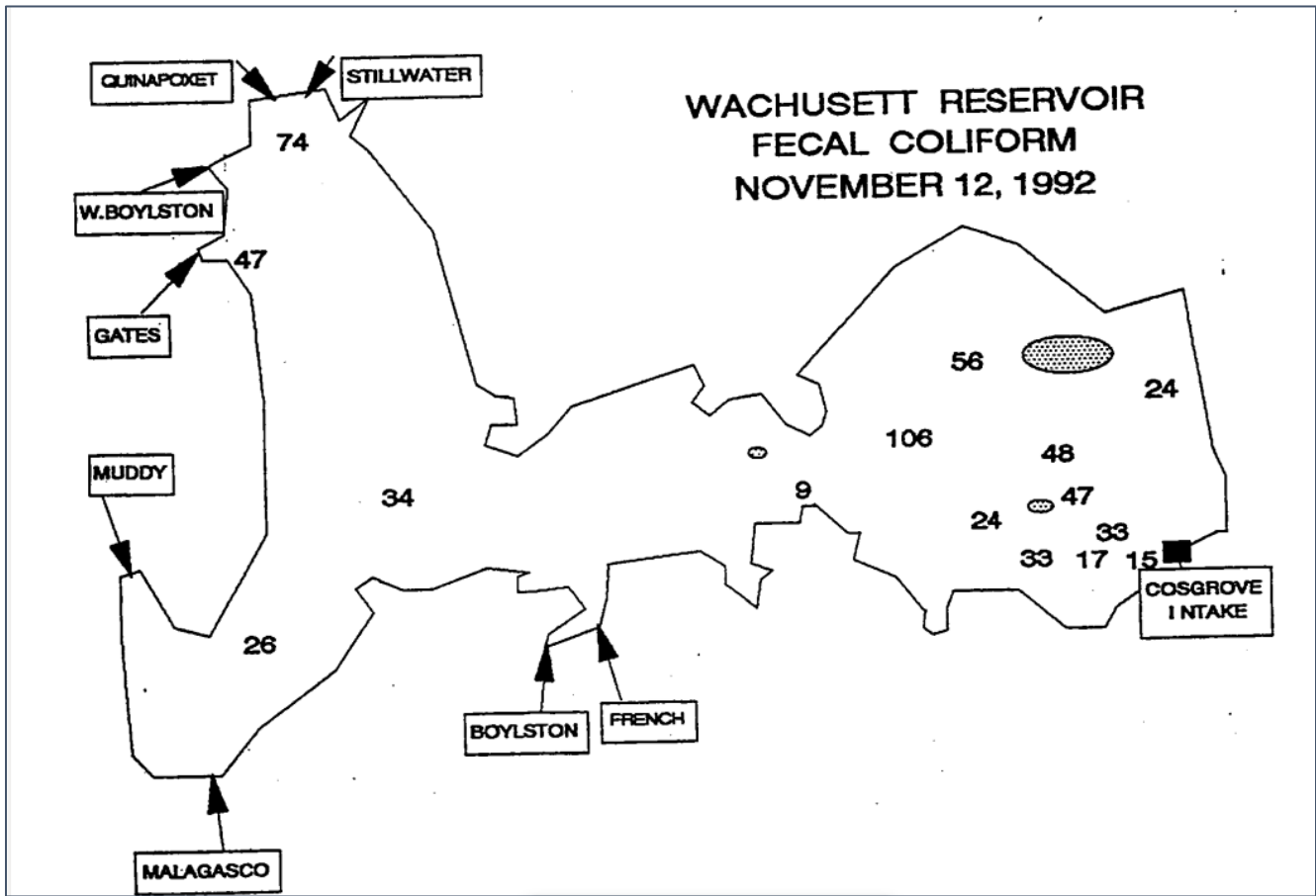
Figure 11: Sample Locations for 1991



The survey was continued for a second year in 1992. Sampling was reduced to 15 locations, as it was believed that similar information to the previous year could be obtained with fewer sampling stations. One sample set was taken each month from June through December.

This was also the year when the MDC implemented the Bird Harassment Program. As with the previous year, bacteria in samples were low throughout the reservoir during summer months, slowly increasing in the fall at the North Basin. By November the numbers levelled off or were reduced in many areas of the North Basin corresponding to the implementation of the harassment program. While bacteria were found throughout the reservoir it was markedly lower near Cosgrove and higher where the birds were being sent than in the previous year (Figure 12).

Figure 12: Sample Locations for 1992

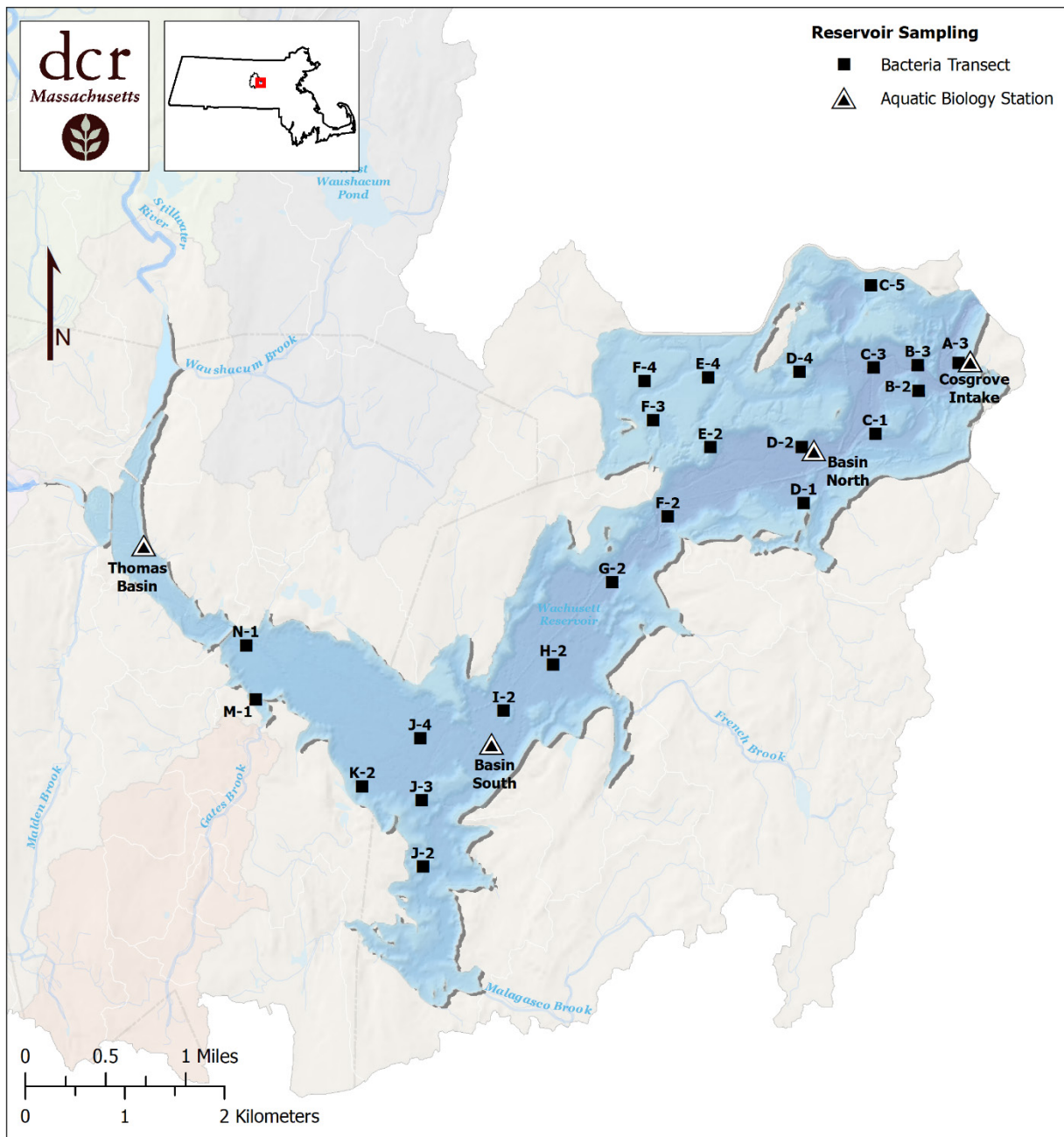


## 6.2 Sampling Program Continues

This method of dividing the reservoir into a grid and sampling for fecal bacteria continues to the present day. The Wachusett Reservoir Bacteria Sampling, or Bacteria Transects, has proven valuable in determining the problem areas resulting from roosting birds in order to focus harassment efforts at those locations and to assess the success of these efforts. Current transect sampling takes place monthly at 23 fixed surface locations, increasing to twice per month during harassment periods (Figure 13). All samples are analyzed at the MWRA lab in Southborough, MA.

Each location has been recorded using GPS, a change from using landmarks and written descriptions. This has been helpful for navigation and consistency when fog or rain make locating visual landmarks difficult.

Figure 13: Current Sample Locations



### 6.3 Cosgrove Intake Sampling

Water samples taken at the Cosgrove Intake facility by the MWRA were collected to fulfill the water quality mandate under the SWTR. Additional samples were taken by the MDC to guide and assess harassment efforts. Regulatory sampling for fecal coliform at Cosgrove Intake continued until August 1, 2005, when it was moved to the newly constructed Carroll Water Treatment Plant in Marlborough. Today a sample is taken daily (365 days a year) by MWRA staff, analyzed at the facility, and reported to various staff and government agencies.



## 7 Gull/Bird Control Program Planning and Development

### 7.1 Program Planning

MDC staff from the Environmental Quality (EQ) and Natural Resources (NR) sections began planning a program to control the bird presence in early 1992, according to a *"Draft Action Plan for Wachusett Gull Problem."* This program would consist of both long term and short-term strategies.

Long-term control: Reduce the gull population using the reservoir by eliminating the nesting population and removing/controlling regional food sources. Convene a task force consisting of governmental agencies and facility operators to guide these efforts.

Short-term harassment: Train gulls to avoid the Cosgrove area in favor of locations farther away from the intake using a variety of harassment techniques through a Bird Harassment Program.

- Harass gulls with pyrotechnics during the time they arrive to roost (late afternoon to evening).
- Install visual deterrents such as "Scary Eyes." Vary locations and visual patterns.
- Play recorded distress calls at various times and locations. Use in conjunction with pyrotechnics as well.
- Reservoir management. Low reservoir elevations expose more shoreline, increase shallow area, potentially attracting more gulls. Maintain highest possible elevation during active season while balancing reservoir operational and water quality needs during Quabbin transfers and flood control.
- Record data: gull numbers, behavior, and effectiveness of control efforts.
- Potential additional measures: habitat modification and use of remote-controlled aerial drones.
- Remove nesting gulls.

Mid-October 1992 was targeted as the time when the active harassment program would commence, when there would be a smaller and more manageable population of gulls to deal with rather than in mid-November when the gull population substantially increases and bacteria levels would be higher. Harassment would be done by staff on shore and in boats launching pyrotechnics during the late afternoon and evening hours. Auditory and visual harassment devices would be stationary and mobile as well. Other species such as geese would be included as necessary.

The goal would be to move all roosting gulls away from the Cosgrove area, through the Narrows (at Greenhalge Point) and as far south as possible (Figures 14 and 15).

Figure 14: Bird Harassment Zone

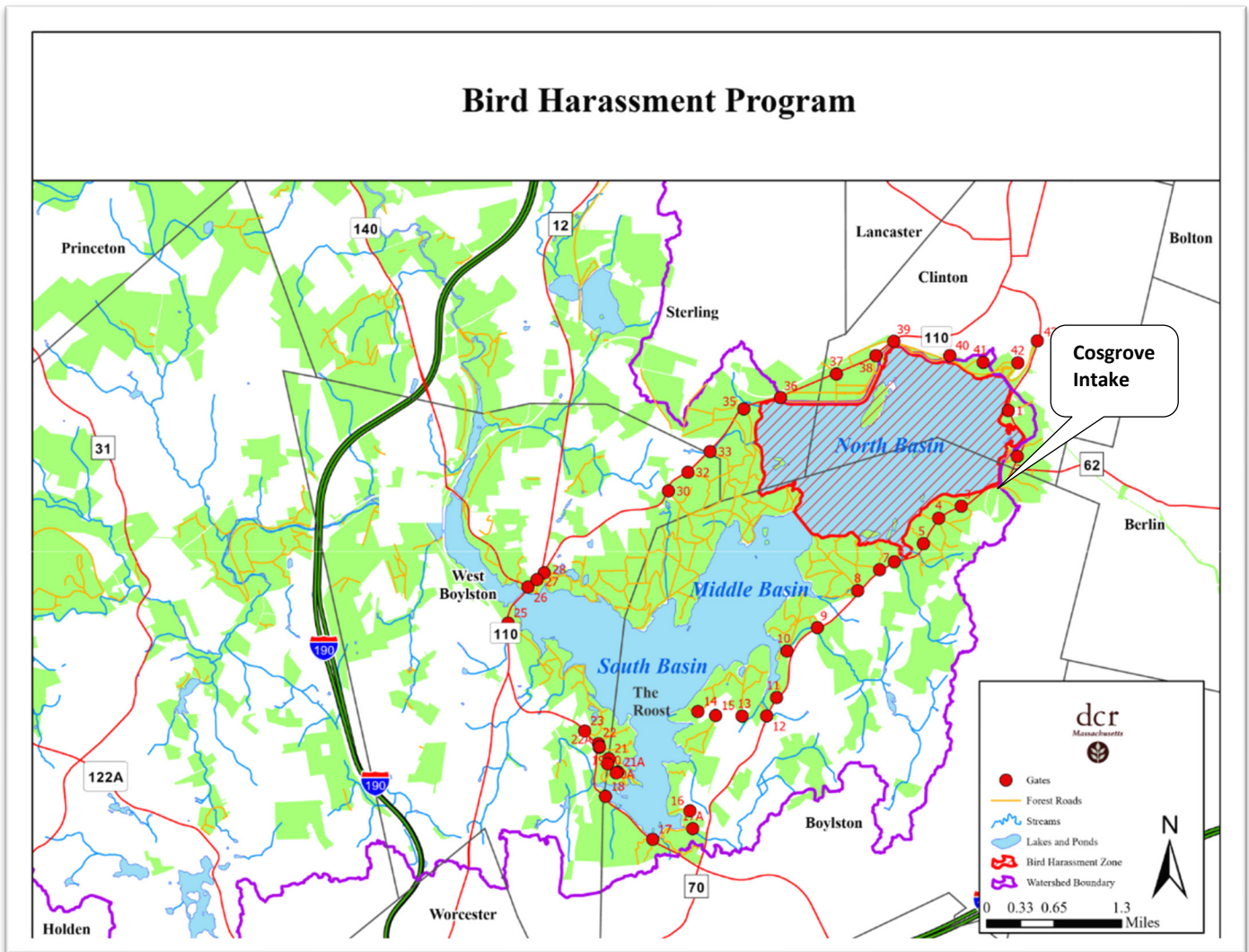
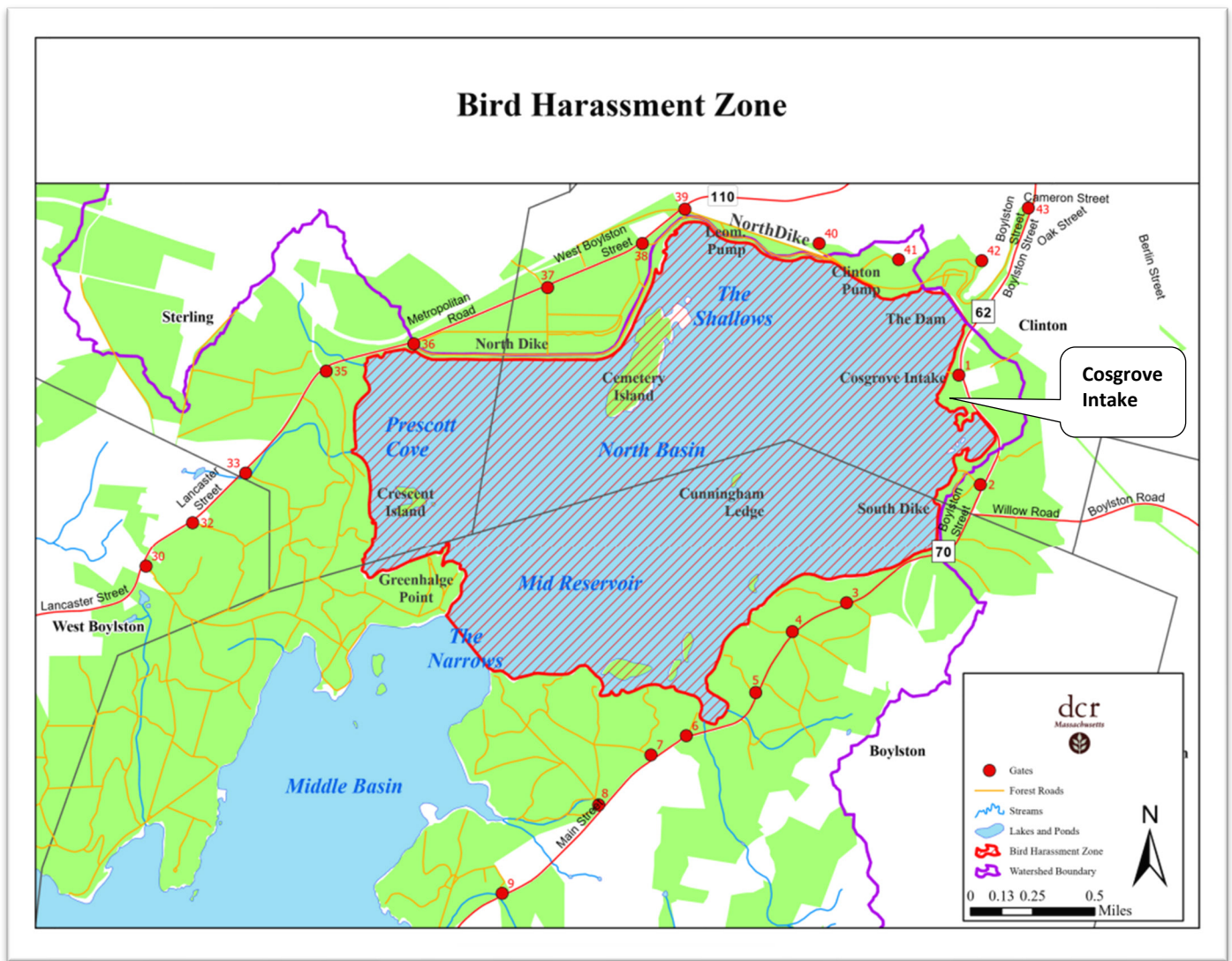


Figure 15: Bird Harassment Zone at North Basin



## 7.2 Technical Advisory Committee

Assisting in the development of the Bird Harassment Program was an advisory committee composed of representatives from several state and federal agencies. The committee was formed in 1992 during collaboration with personnel from the USDA-Animal Damage Control office. Members of the group included those from the MDC-Division of Watershed Management Quabbin/Ware and Wachusett Sections, Massachusetts Water Resources Authority, Massachusetts Division of Fisheries and Wildlife, and U.S. Department of Agriculture Animal and Plant Health Inspection Service – Animal Damage Control. The Committee met periodically and as needed. Later, at a meeting on October 14, 1993, the title of the group was formalized into the MDC Bird Harassment Technical Advisory Committee (TAC) and meetings continued as necessary, until disbanding sometime after 1999 when it was deemed no longer necessary due to the program consistently meeting its goals.

## 8 Bird Harassment Program First Season: 1992-1993

### 8.1 Summary

Management of the program was the responsibility of Environmental Quality (EQ) staff who participated in harassment roles on shore while staff from other sections were responsible for harassment from boats. Natural Resources staff were also responsible for population reduction activities.

Active harassment was conducted seven days a week and commenced during the late afternoon and evening hours as gulls settled into their night roosts. Harassment consisted primarily of pyrotechnics launched by MDC staff from boats and shore throughout the North Basin (Cosgrove area) with the goal of moving them south to the open water of the South Basin or directly off the reservoir. Boat presence was also a form of harassment.

In addition to pyrotechnics, amplified recorded distress calls were broadcast at varied times from either land or shore-based locations, propane noise cannons were activated from shore.

Monitoring and data collection was made by shore personnel before, during, and after daily activities to gauge program effectiveness and guide modifications.

The Natural Resources section counted the number of gulls at the South Basin and the direction from which they arrived to determine whether harassment was successfully moving birds from the North Basin.

Data collected was analyzed to determine if other bird species such as Canada geese, cormorants, and several species of ducks utilizing the reservoir posed enough of a problem to warrant harassment as well.

## 8.2 Program Commences

Program operation began in September with observations of bird numbers and behavior at the North Basin. Active harassment from shore and boats began on October 20, 1992, when the gull presence had increased enough to pose a contamination problem.

Staff from several watershed sections were divided into two teams of two staff each. One team operated a boat and launched pyrotechnics while the other team was positioned on the North Dike also launching pyrotechnics. Harassment was focused on the North Basin with the boat going only as far as the "Narrows," the open water between Greenhalge Point and Sawyer Bluff. From there it was hoped that the gulls would continue flying to the South Basin to roost, where it was assumed was far enough from the intake to pose a problem.

In addition, one propane noise cannon and the distress call broadcaster were installed on the Cosgrove balcony, another cannon was installed on the north end of Cemetery Island, and another on "No Name Island," later referred as the "Shallows." Cannons were set to fire at 15–20-minute intervals, alternating among the devices. Pyrotechnics consisted of "Shellcrackers" launched from 12-gauge shotguns and "Bangers" and "Screamers" launched from modified .22 caliber pistols. Shellcrackers have a range of about 200 feet while Bangers and Screamers have a range of approximately 75 feet.



Approximately 275 gulls were present the first evening which ran from 6:00 pm to 7:30 pm and all birds responded by leaving the North Basin. During harassment, staff on shore recorded the following data: gull numbers, roost locations, harassment responses, and pyrotechnic rounds fired. Given the small number of birds present that evening the decision was made to proceed with harassment from shore only until bird and bacteria numbers increased or birds became unresponsive to harassment from shore.

Two weeks later (November 12), after increasing bacteria numbers, a boat team was included again. As before, the boat crew launched pyrotechnics but also followed the explosions with a distress call. Shore staff also launched pyrotechnics. At dusk the propane cannons were activated and remained operating until one hour after dark. MWRA staff operated the cannon at Cosgrove; MDC Program staff operated the other two.

Staff soon realized, with gull numbers increasing, that when they harassed with the boat the gulls would double back to the spot they were harassed from, so a second boat was added.

Gull numbers continued to increase as November progressed, ranging from 200 to 450 each evening, with bacteria numbers fluctuating depending on gaps in between harassment days and numbers of gulls present. Unfortunately, for a variety of reasons, such as adverse weather and equipment problems, the harassment program could not be run every day.

Occasionally bacteria numbers were elevated despite harassment efforts. One theory for this increase was that the program was ending too early and additional gulls were arriving after dark. An effort was made to extend the program, however operating after dusk presented other problems such as safety and reduced visibility. The reservoir had begun freezing over by the end of December. Harassment became complicated by the resulting patchwork of ice cover and open water. Gulls congregated in the open water and ice cover prevented boats from reaching them.



*Gulls rest on edge of ice sheet during ice over*

Following a near complete freezing was a warming trend along with rainfall events which caused the ice to melt. A sample taken at Cosgrove on January 4 resulted in a coliform level of 330 cfu, well over the regulatory threshold of 20 cfu. It appeared that this resulted from gulls roosting on open water and resting on ice while the reservoir was freezing. This concentrated them in smaller and smaller areas where bacteria collected. Then rapid melting of ice that followed resulted in an influx of contamination.

Shortly after, the reservoir began freezing again and on January 11 with boat launch areas frozen the use of boats ceased entirely. Land based harassment became the only option and the effectiveness in moving birds from shore decreased when birds roosted out of pyrotechnic range. Other complications to harassment were winter storms and the variable patterns of ice and open water. By January 25 harassment was no longer effective and operations ceased. Bird presence continued to be monitored and numbers recorded until the reservoir completely froze on February 25 and gulls left the area. During the time from January 11 when boats could no longer be used to complete freeze (46 days) there were 15 exceedances of the 20 cfu/100ml standard.

The official time frame for the program was October 20, 1992 to February 25, 1993. A total of 129 days of which there were 46 days of boat and/or shore harassment with 35 exceedances out of 65 samples.

Consecutive Program days	Harassment days	Sample days	Exceedances	Ave # Gulls	Max # Gulls	Min # Gulls
129	46	65	35	858	3500	15

Additional data can be found in detail in a report titled "Gull Control Program Summary March 3, 1993." Raw data in the report includes harassment methods, precipitation, Quabbin flow, gull numbers, personnel, equipment, and maps of coliform distribution.

See chart in Appendix C for the relationship between the number of gulls present in the North Basin and the bacteria in water samples taken at Cosgrove.

### 8.3 Assessment

The first year of the program was essentially a pilot program to determine if birds would respond to harassment and relocate to another area for roosting as well as assess the feasibility and effectiveness of various harassment techniques. In this regard it was a very successful program. Birds responded to harassment, although it appeared harassment would be necessary more often as birds returned each evening despite being harassed the day before. Bacteria exceedances were much less frequent than in previous years.

Of the many harassment techniques and devices which were tested under actual conditions, pyrotechnics stood out as the most effective.

Results of harassment tools:

- Propane cannons – initially frightened gulls but they adapted quickly.
- Recorded distress calls – similar results as cannons.
- Boats – increased locations for harassment, moved birds easily, success at chasing gulls but additional boat needed.
- Pyrotechnics – moved gulls immediately but range is limited. Most effective when combined with a boat. "Screamers" seemed most effective.

Issues to be addressed for the next program:

- Partial ice and open water conditions concentrated gulls and fecal bacteria into smaller and smaller areas, usually outside the range of shore harassment. Sudden melting released bacteria.
- Ice at the boat launch prevented boat use during critical times.
- Gull counts did not consistently correlate with bacteria numbers suggesting there are more factors involved.
- More research is needed regarding bird behavior after sunset.

Other items for consideration:

- Utilize remote controlled plane for harassment.
- Explore using standard fireworks with a licensed vendor.

- Locate an EQ observer at the South Basin to monitor bird behavior.
- Pursue purchase of a hovercraft for use during partial ice conditions.
- Monitor area landfills and sewage treatment plants for management of gull feeding.

#### 8.4 *Nesting Addressed*

With active harassment having concluded, measures were begun to eliminate the breeding colony estimated to date back to the mid-1960s. A count of birds nesting on Cunningham Ledge made on April 21, 1993, determined that approximately 100-125 gulls comprised the colony. Staff from the Natural Resources section added 85 eggs in 49 nests by treating them with a sealant, shaking them or slightly puncturing them to prevent offspring from developing. The eggs were returned to the nest to prevent gulls from laying more. Only two chicks were seen as of June 1. All work was done in accordance with a federal permit issued by the US Fish and Wildlife Service.

A workplan developed by the State Director for USDA-APHIS Animal Damage Control for potential use of the pesticide Avitrol on the nesting population was reserved for future use.

On a historical note, a much earlier attempt to remove the colony is referred to in an MDC Water Division Annual Report from 1971 which states "A further attempt was made this year to curtail the population of seagulls at the Wachusett Reservoir. 17 birds, 74 nests and 629 eggs were destroyed and disposed of. Nesting areas were sterilized with the application of calcium hypochlorite. Wachusett personnel applied 300 lbs. to areas of barren island (Cunningham Ledge). In order to decontaminate sea gull spoils."

## 9 Second Season: 1993-1994

### 9.1 *Planning*

Planning for the second season began in June and was finalized in September during meetings of the TAC. The goal and methodology remained the same: use harassment to move as many birds as possible from the North Basin to the South Basin where it was hoped a southern roost would be established. Harassment would be focused on the North Basin with the boat only going as far as the "Narrows" – the area between Greenhalge Point and Tahanto Point. A detailed workplan was drafted. The program would be managed by staff from the MDC Environmental Quality Section with technical advice continuing from the TAC.

It should be noted that while all this activity was occurring, the MWRA was working with MassDEP and EPA to comply with the federal source water quality regulations. The program was fully supported by the MWRA and although it required significant resources and effort, it was considered one of the most important tasks being undertaken by MDC staff.

### 9.2 *Workplan Summary*

- As with the previous year, early fall was targeted for program start as birds move to the reservoir in large numbers. Operation would be seven days per week from late afternoon to evening, ending at darkness.
- Pyrotechnics launched from shore and boats would be the primary means of harassment. Use of propane cannons and recorded distress calls would continue.
- EQ staff on shore would be responsible for launching pyrotechnics, operating propane cannons and distress call broadcasting devices, directing boat activities, and recording bird numbers and harassment activities. Boat staff responsibility would consist of launching pyrotechnics, coordinating with shore personnel, and counting bird numbers.
- Staff would continue to identify the core number of birds using the reservoir so the program could be adjusted accordingly. Bird locations and numbers would be counted on Thursdays at four different locations. Once the core group reaches 200 gulls the boat would be deployed.
- Bird numbers in two locations at the North Basin and one at the South Basin would be counted weekly to determine if birds were moving there as a result of harassment.

- Sampling for fecal coliform bacteria would continue three times a day at Cosgrove by MDC staff in addition to samples taken daily by the MWRA.
- Transect sampling would be conducted as needed.
- Biweekly activity reports would be written.
- Guidelines for lethal activity to eliminate nesting birds and reinforce harassment would be developed, including both shooting and use of Avitrol, a pesticide.
- MWRA would be requested to record the number of gulls observed from Cosgrove in the morning.
- The potential for problems associated with gulls roosting on the Cosgrove facility would be investigated.
- Starlight night scopes would be used if available to determine if birds are arriving at the North Basin after dark.
- A permanent boat dock with sufficient lighting for work after sunset would continue to be sought.
- Vegetation from the Shallows and Cunningham Ledge would be removed to increase the visibility of birds from shore.

### 9.3 *Fall/Winter Operation*

The program began on October 4, 1993, with EQ staff counting birds daily at the North Basin each afternoon until dark. On this first day, the MWRA recorded 30 cfu in the daily sample taken at Cosgrove, an exceedance of the regulatory threshold. Total bird numbers recorded each evening over the next few days ranged from approximately 500 to 1,000 birds, triggering the start of the active harassment program on October 12, 1993.

A boat crew of two people patrolled the North Basin harassing birds with pyrotechnics while one person on shore harassed from the North Dike from gate 36 to gate 41. The boat was deployed two hours before sunset and continued harassment activity until dark.

Bird numbers continued to rise prompting the addition of a second shore person on October 18. This second person was able to cover more area on the North Dike for observation and launching pyrotechnics.

A count of 1,360 birds on the reservoir on November 2 prompted the addition of a second boat on November 8. Harassment proved effective in moving gulls and keeping fecal numbers low, so on November 18 the boats were launched one hour later. Harassment continued to be effective; on November 29 the second boat was dropped from launching. By this time birds were responding to harassment or else bypassing the North Basin altogether.

Harassment remained successful for another three weeks until December 22. Smaller bodies of water in the region had frozen pushing more birds to open water at the reservoir and a water sample taken that day exceeded the regulatory threshold at 27 cfu. Strong winds directed at Cosgrove the previous day were considered part of the reason for this exceedance.

By December 28, the boat cove had frozen, and boats were no longer an option. Shore harassment continued and was successful towards gulls, however geese and ducks were unresponsive. Without a boat presence those birds remained on the reservoir each evening. Throughout the next three weeks gulls were still responding to harassment from shore, however, geese and ducks were not, and they numbered in the hundreds each night. Five fecal coliform samples taken by the MWRA exceeded the regulatory threshold prompting an emergency discussion of additional harassment measures.

Potential response options discussed included:

- Add louder distress calls using a professional sound company. Three-day rental of sound equipment secured.
- Add goose distress calls if available.
- Borrow a hovercraft from an area town. Not a possibility with Shrewsbury who cited insurance reasons.
- Obtain commercial flares. Proved not bright enough.
- Obtain different pyrotechnics from the State Fire Marshall's office.



- Obtain explosives from Fort Devens.
- Use Avitrol (a bird repellent pesticide).
- Use a helicopter or plane. Helicopters were scarce and expensive. A contract with a private company was possible.
- Shoot roosting birds with a crossbow or silencer after dark to avoid startling them.

Fortunately, on January 17, 1994, the reservoir had completely frozen over and active harassment operations ceased. Even more fortunate, the reservoir remained frozen until spring when gulls begin to disperse to coastal and northern locations.

#### 9.4 *Spring Activities*

After ice melt a less intense harassment program was initiated on April 1. Each evening for two hours before dark, one EQ staff person was positioned on shore around the North Basin to observe birds and launch pyrotechnics as necessary. Propane cannons were used on Cunningham Ledge to prevent nesting. An improved system for broadcasting distress calls was used on an experimental basis. Boats were not utilized.

This period began with approximately 200 gulls offshore of Cunningham Ledge. By April 11, the number had increased to 400 and an experiment with the new distress call system began. Speakers were mounted on a vehicle which patrolled the North Dike for three days. The birds were only responsive when the calls were broadcast in conjunction with pyrotechnics.

By the last week in April the number of birds being harassed each evening numbered approximately 200. Most were responsive to harassment which continued until June 1, at which time the number had dropped to 100. These gulls were primarily located near Cunningham Ledge, and it was assumed they were associated with the breeding colony that had formed there.

Construction of a wire grid over Cunningham Ledge prior to the nesting season was not possible due to the presence of ice, so pyrotechnics and the propane cannon were used to deter birds from establishing nests and to motivate those already there to move. Existing nests and eggs were destroyed. Still, these efforts were met with only limited success. Trapping was attempted in early June but was only partially successful. It appeared that after harassment the gulls were hesitant to enter the traps and only 15 gulls were captured. An attempt at shooting was unsuccessful as the first shot drove the gulls away. Egg destruction followed this and 69 of them were punctured. A week later, four new eggs were found. Avitrol was discussed but was rejected due to concerns by the MWRA over its use at a water supply.

#### 9.5 *Program Evaluation*

The program was successful in reducing fecal coliform bacteria levels dramatically from those of previous years, although some exceedances still occurred. A quick comparison to the two previous years showed the effectiveness of the program: 1991, when no program existed, 73% of samples exceeded the regulatory limit; 1992, during the pilot program, 38% of the samples were exceedances; 1993, with a more intense program, the number was down to 6% of the samples.

Other assessments from 1993-1994 program include:

- Pyrotechnics launched from the boat and shoreline remained the most effective method of moving birds.
- Other harassment techniques met with mixed results. Propane cannons were effective at first but were subject to mechanical failure and their use was discontinued after a short period. Distress recordings projected from shore were ineffective during the fall/winter program. An experiment with a louder broadcast system during the spring proved more effective when used in conjunction with pyrotechnics.
- Gull response was consistent once harassment had been constant for a few weeks. Birds were easy to move for the most part, although they sometimes tended to resettle on the water and had to be harassed a few more times.
- At times the boat was effective on its own at herding or pushing birds past the Narrows without pyrotechnics.

- It appeared that gulls had become “trained” as the program progressed. On some evenings when there wasn’t harassment they would move on their own to the South Basin. They also appeared to be avoiding the North Basin at times.
- MDC bacteria samples and MWRA samples were generally in agreement suggesting there would be no need for redundant sampling by the MDC.
- Morning observations from Cosgrove revealed that few birds were present, likely meaning that birds were not returning to the North Basin after dark.
- Transect data revealed that the number of bacteria present throughout the reservoir was consistent with harassment efforts. In 1991 when the number of birds was high and there wasn’t a program, bacteria numbers were elevated throughout the North Basin and especially high at Cosgrove. The first year of harassment and this year saw a steep reduction in bacteria in these areas.
- Ice cover on the reservoir continued to be a problem. Given that much of the harassment season involves months where freezing occurs this will be a perennial issue. Early freezing of the boat cove and the concentration of birds and bacteria on ice patches and in open water will need to be addressed.
- Geese and ducks became more numerous later in the season and were mostly resistant to harassment. Additional methods may be needed to target these species.
- It could not be determined if birds moved to the North Basin after the program ended but it was suspected. Lighting at the boat launch was constructed late in the season and was incomplete so operating at night was not an option. Starlight night vision scopes did not work well.
- New equipment improved the boat operation. Survival suits for use on boat during cold weather improved safety and radios installed in boats replaced portable units improving communication.
- Further research was identified: the influence of water transferred from the Quabbin Reservoir on bacterial transport; the ability of bacteria to live longer in cold environments; and the effect of the wind on the viability and transport of bacteria.

#### 9.6 *Recommendations for the upcoming third season:*

- Upgrade the sound system for broadcasting gull distress calls.
- Improve MWRA morning gull observation.
- Obtain a hovercraft for use during partial ice conditions.
- Research harassment techniques for geese and ducks.
- Use Avitrol (pesticide) where appropriate (i.e., under partial ice conditions when boat use wasn’t possible, and birds were out of pyrotechnic range).
- Continue efforts to reduce regional food sources especially landfills.
- Deter nesting using a wire barrier grid or netting. Install before nesting season in March or April. Depends on presence of ice.
- Communicate with New York City water supply staff for issues in common.
- Improve boat dock and boat launch area.
- Consider suggestions for control or elimination of breeding gulls outlined in a USDA Animal Damage Control report. Action items include habitat modification, exclusion, harassment, nest and egg treatment, wildlife removal, chemical treatment, shooting or any combination of these items.

## 10 Third Season: 1994-1995

### 10.1 Planning

The methodology of the program's third season remained the same as the previous two; harass birds from the North Basin to the South Basin using pyrotechnics from land and boats, distress calls and other means.

In addition, several issues for the upcoming program were discussed over the summer during meetings with program management and the advisory committee. Some of the issues discussed included:

- Answering the question of the proper distance that birds should be driven from the North Basin and Cosgrove Intake. Was the current target of the South Basin acceptable or should the focus be to send them even further away towards the causeway. The resulting decision was that unless there was new information, sending birds past the Narrows to the current location (the "Roost") would be sufficient. The Roost being the area in the South Basin where gulls went after being harassed.
- Exploring the question of whether moving gulls from Wachusett sends them to Quabbin which, if true, would require rethinking the operation of the program. Nothing conclusive was determined.
- Determining the feasibility of removing Cunningham Ledge moved forward with the preparation of a contract for FY95. This would involve blasting the rock ledge with the work possibly being done in conjunction with a spillway rehabilitation project.
- Monitoring area landfills by the NR section for compliance with gull management plans should continue.
- Answering the question of whether pyrotechnics which required firearms to launch them required a firearm permit. The question was referred to the State Police who responded that firearm permits were not necessary if used on state property. This was important as more personnel would be able to participate in the program. It was later determined that permits would be needed.
- Acquiring two hovercraft was moving along in the purchasing process with the hope that the vehicles would be available for use at program start. This would require improvements at the boat ramp and staff training in their operation.

### 10.2 Implementation

The targeted mid-October start date was moved to the first week in September following exceedances of the 20 cfu/100 regulatory threshold during the prior week. The basic structure and goal of the program remained unchanged from the previous seasons.

The number of gulls being harassed in any one single evening during this season ranged from less than 50 to approximately 4,000 individuals. Despite such large numbers no regulatory violations occurred and the season concluded successfully, establishing the Bird Harassment Program as a necessity for meeting water quality standards.

Details of this season are not included here as with the first two seasons but can be found, along with written descriptions of subsequent seasons, in other documents such as yearly Water Quality Reports, Annual Work Plans, Watershed Protection Plans and Bird Harassment Summary Reports.

## 11 Important Annual Highlights 1989-2022

### 11.1 1989 - Compliance Sampling

Fecal coliform testing at Cosgrove is added to the existing sampling array of water quality parameters to evaluate compliance with the new water quality standards. Prior sampling involving coliform was for total coliform only. Sample results are submitted to MassDEP and the EPA.

## 11.2 1990-1991 - Sewage Investigated

Fecal coliform levels in samples from Cosgrove were so high that EQ staff conducted an intensive investigation of the surrounding area in search of sources. Sewage disposal from buildings was checked for proper operation and stormdrains were sampled for fecal coliform. No sources other than roosting gulls were found.

## 11.3 1992 - BHP Season 1

First Bird Harassment Program operates October 20, 1992 to February 25, 1993.

## 11.4 1993 - BHP Season 2

Second Bird Harassment Program operates fall 1993 to spring 1994.

### Remote vehicle use

An individual contacted by the MDC stated he is “willing to do a video/slide presentation for us on his on use of his radio-controlled boat. He is available at our request.” Uncertain if this was followed up on but similar ideas have been theorized since.

### Depredation permit

An initial Depredation Permit was issued by US Fish and Wildlife Service allowing lethal means for bird control. Expected use is for elimination of nesting birds and reinforcement of harassment methods. Migratory birds are protected from lethal means; however, no permit is required for harassing them. Permits are valid for one year and the terms vary from permit to permit. This permit allows the taking of no more than 10 gulls per day and no more than 200 per year. It also allows for destruction of up to 150 eggs by addling, oiling, or puncturing and the use of the pesticide Avitrol.

## 11.5 1994

Third Bird Harassment Program operates fall 1994 to spring 1995.

### Hovercraft

Two hovercraft were purchased for use during winter operations when the combination of ice cover and open water complicate harassment. While the vehicles proved effective in getting crews close to the birds, they were difficult to operate in rough water and, without enclosures, left the crew exposed to adverse weather conditions. Two better equipped all-weather hovercraft were later purchased.

### Nesting gulls

A request for assistance with removing the colony of nesting gulls on Cunningham Ledge was made to USDA Animal Damage Control by MDC staff on April 6. The use of the pesticide Avitrol as a means of controlling gull populations was discussed but raised concerns among MWRA staff that using such as chemical so close to the water supply was a serious public perception problem with possible health concerns and the justification did not appear to outweigh the negatives. The MWRA suggested focusing on continuing the harassment program without it.

## 11.6 1995

### Bacterial transport

A bacterial transport study was conducted to answer the question of whether the current practice of sending birds to the southern portion of the reservoir was sufficient to reduce or eliminate the threat of contamination. The engineering firm Camp Dresser McKee studied the situation and reported the results in “Wachusett Reservoir Water Quality: Interim Assessment”, August 1995. The consultant concluded that moving birds to the Roost (roughly four miles from the intake) would provide from 36 to 72 hours of travel time before fecal coliform loads reached the Cosgrove Intake. Therefore, based on this travel time and the additional exposure to solar radiation and other die-off considerations, it was concluded that the Roost area was far enough away from the intake to keep coliform levels below the standard for fecal coliform under most conditions.



*Rock in Carville Basin netted to prevent roosting and nesting.*

Other relevant findings:

- Surface water from the South Basin moves northeast at low velocities: 0.02 to 0.04 meters/second.
- Sustained winds can alter flow patterns, accelerating or decreasing the time of travel to or from the Roost.
- Flow from tributaries does not appear to be a factor in bacterial transport.
- Factors affecting transport and distribution: loading rates, water temperature, sunlight duration, currents and velocities, mixing of the water column, settling, wind speed and direction, bacterial growth and die-off.

**Stationary harassment devices**

Harassment tactics added to the program for use during the day included installing stationary frightening devices (“Scary Eyes”) that mimic predators and netting on rocks in Carville Basin and on the Shallows to prevent roosting and nesting. Both measures were effective initially however over time their effectiveness in deterring birds declined.

Lower reservoir elevations increase the amount of area beyond the effective range of the scaring devices and expose more rocky area requiring more netting. Ice and wind damage the scaring devices and netting requires constant maintenance during adverse conditions. Details of these devices and an analysis of their effectiveness are described in a report by Natural Resources staff. See Lanza, H. and Clark, D. in References.

*11.7 1996*

**Agriculture**

Watershed land immediately adjacent to the North Dike, in the Gate 36 area, which had been leased to a farmer to grow crops, was recognized as an attractant to geese. The lease was cancelled.

**Roost counting**

Natural Resources Section begins routine counting of gulls comprising the “Roost” at the South Basin during the week. Data collected is useful to estimate the gull population using the reservoir as well as gauge the success of harassment efforts. More gulls at the Roost should mean less at the North Basin.



*“Scary Eyes” imitation predator on rocky outcrop*

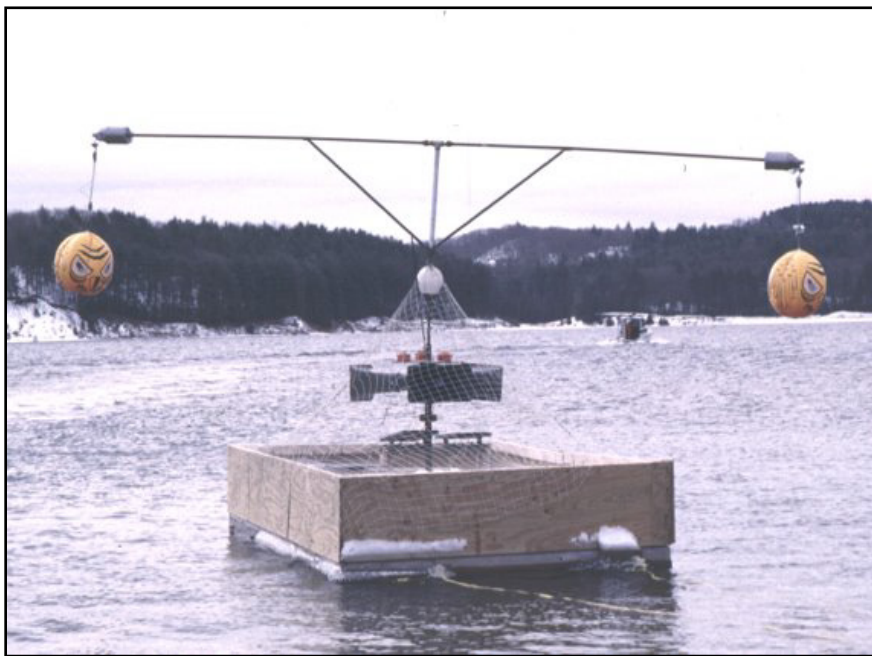
## 11.8 1997

### Last nesting gulls

A small group of ring-billed gulls attempted to establish a nesting colony on Cunningham Ledge during the summer. Approximately 10 nests with 16 eggs were added and no further nesting attempts were made this year or at any other time since.

### Remote distress calls

A sound machine of recorded gull distress calls was installed on a raft deployed near the Shallows with the ability to operate remotely or on a timer. Previous machines were installed on shore locations without lasting results. Locating the machine on a raft was designed to get better results by being able to operate closer to where gulls roosted. Unfortunately, this effort failed. The machine was difficult to operate, and gulls were not bothered by the sounds.



### Control of feeding at landfills

Reducing regional food supplies at area landfills was the focus of "A Manual for Gull Control at Massachusetts Landfills" created by the Natural Resources Section in collaboration with MassDEP and MA DFW as result of the past several years of working with landfills in the Wachusett region.

### Roost monitoring

An additional shore-based staff person was assigned to monitor the Roost at the South Basin in response to recent events where birds suddenly left the Roost and flew back to the North Basin. This person would alert staff at the North Basin who would then be able to get into position to harass before they could settle on the water. Once settled, the roosting birds are less likely to move especially towards dark. This was in addition to NR staff counting birds in the Roost once per week.

### Helicopter

According to an MDC document the "Massachusetts State Police provided the use of a helicopter to...observe and direct the harassment program...the helicopter was also used to herd birds south once harassment from the shoreline, or boats got the birds off the water surface. However, the pilots expressed their conclusions that the risk of one or more birds coming into contact with any part of the aircraft while in flight could be fatal and that it was their considered recommendation that the helicopter should not be used for this purpose."

## 11.9 1998

### Morning and daytime harassment

Morning Harassment during winter months remains problematic. Additional measures are proposed: assign staff to observe and harass if necessary, at the North Basin in early morning hours to detect overnight roosting. Make staff available for daytime harassment weekdays and weekends.

### Contamination at Cosgrove

Fecal coliform bacteria exceedance on June 1 prompts in investigation of Cosgrove area. Deposits of gull feces on the roof and catwalk of the facility were observed and rain the previous day may have washed some of it into the reservoir. Additionally, a stormwater detention basin nearby at gate 1 was observed to contain goose feces as well as actual geese and

goslings. Solutions proposed included installing devices on Cosgrove to prevent roosting, installing a drainage system to prevent runoff from directly discharging into the water and removing goose nesting sites from the basin. All proposals were eventually implemented.

#### Quabbin transfer

The question of whether the transfer of Quabbin water pushes bacteria from the Roost to Cosgrove faster is raised again. While a prior report by a consultant (CDM) concluded that transfers do not affect transport, a recent two-year comparison suggests there may be some correlation between fecal coliform levels at the intake and those during transfers. Fecal coliform thresholds were then set offshore of Cosgrove in order for a transfer to be initiated. The MWRA would gather specific monitoring data. It's uncertain if further action was taken.

#### Nesting abandoned

A survey done by the USDA-ADC reported no gulls nesting on Cunningham Ledge unlike the previous year.

### 11.10 1999

#### Water quality violation

Bird activity during the 1999 winter months resulted in 14 exceedances of the 20 CFU/100mL water quality standard (albeit by very nominal levels). One more than the 13 allowed for maintaining compliance. This represented the first violation since 1993 of the source water quality criteria for fecal coliform.

The number of gulls present at the North Basin during this time ranged between 1,500 and 2,000. – large numbers but not historically high. This highlighted the persistent problems conducting harassment during adverse weather conditions in winter months, natural factors influencing bacteria transport and the combination of ice and water complicating operation.

#### Exceedance Response

MDC developed a plan to include additional measures to the existing bird harassment program in response:

- Purchase larger hovercraft better suited to operate in difficult winter conditions to include a heated enclosure.
- Pursue acquisition of a military amphibious vehicle known as a “Lark” for use as a platform for launching pyrotechnics.
- Complete construction of a permanent dock to improve the reliability of watercraft deployment, storage and fueling during winter weather. Completion estimated by fall 1999.
- Construct a wind energy baffle across the Narrows to hinder bacterial transport from the southern portion of reservoir. Install estimated by fall 1999.
- Construct a filter curtain in front of Cosgrove to inhibit bacteria infiltration.
- Keep Avitrol as an option for removing birds. Complete a draft plan for its use by July 1, 1999.
- Expand fall harassment program to all daylight hours (dawn to dusk) as of December 1, 1999. Sooner if necessary.
- Reinforce harassment with shooting when necessary.
- Develop a plan for full reservoir harassment with the goal of moving birds completely from the reservoir. Finalize by July 15, 1999.
- Initiate and design a regional population and food source study relating to gulls for discussion by January 2000.

Items completed:

- Improved boat docking and launching facilities greatly enhanced boat and hovercraft use in cold weather conditions. The docking area was expanded, circulators kept water from freezing, and lighting allowed for better nighttime use.
- A wind energy baffle, approximately 1,800 feet long, was constructed across the Narrows to impede surface flow from the South Basin to the intake. This boom/curtain remained in place for several years until its effectiveness could not be determined and the structure was degraded from weather.

- A contract with USDA Animal Damage Control for the use of Avitrol is signed June 21 following a request for assistance in reducing the number of gulls roosting on the reservoir. Staff from that agency are one of a few public agencies licensed, approved and capable of furnishing the service. Avitrol is considered useful as it not only kills the birds that ingest it but the resulting behavior after ingesting the pesticide is frightening to other birds causing flocks to abandon the treated area. Prior concerns with its use are addressed with fact that it does not need to be applied at the reservoir only in a location near it to affect the birds.
- *Wachusett Bird Control Program Full Reservoir Harassment Plan* for zero tolerance for birds roosting anywhere on the reservoir is completed. This would greatly expand the current program from harassment at the North Basin only to the entire reservoir. It would require additional resources but would significantly reduce the risk of exceeding the federally mandated water quality standard. Planning for a “full reservoir harassment” program was tentatively set for October, but the program was not implemented until 2016 and then only as a pilot program to determine if such a program was feasible.
- *Operational Plan for proposed use of Avitrol to control gulls at Wachusett Reservoir, Massachusetts* is completed by MDC staff.

#### Program Update

As a requirement of an Administrative Consent Order issued previously by MassDEP for reporting to the EPA, a comprehensive overview of the program is detailed in communication from Joe McGinn, MDC Division of Watershed Management to the MWRA and MassDEP titled “Program Enhancements 2-12-99” regarding current BHP operations and new measures under consideration.

The information provided important written support to MWRA during the height of the litigation over the filtration mandate where the BHP is highlighted as one justification for the granting a waiver.

#### Noteworthy program details:

- The existing program consists of an established bird free zone in the North Basin north of the Narrows.
- Birds are harassed from the North Basin as needed. Harassment measures consist of pyrotechnics launched from shore and boat, periodic use of recorded gull distress calls broadcast over a loudspeaker system.
- Netting and visual scaring devices have been installed at the Shallows, Cunningham Ledge, and Carville Basin to prevent gulls from nesting and roosting close to the intake.
- Periodic lethal measures have been employed subject to a federal permit as a means of reinforcement of other measures. This permit is renewed every year.
- Habitat modification through vegetation removal and mowing has been done to improve the visibility for shore harassment.
- Regional food sources, including landfills and farms, have been identified and measures to control birds feeding from them have been ongoing.
- A hovercraft with an enclosure and heater to allow for more time spent harassing in adverse weather conditions is being considered.
- The acquisition of a large watercraft known as a “Lark” to serve as a pyrotechnic shooting platform is being explored.
- A wind energy baffle curtain is planned for installation across the “Narrows” to impede the flow of bacteria in surface water.

#### Workplan for 2000 additions

Modifications to harassment activities proposed: early evening harassment by September 1, full daylight harassment by December 1, seasonal full reservoir harassment (short-term at critical times using three boats and five staff), lethal measures with USDA and Mass Wildlife.

#### MWRA System Improvement



A major component of the MWRA/MDC Integrated Water Quality Improvement Program is the construction of an ozone/chloramine water treatment plant at Walnut Hill in Marlborough. Construction is scheduled to be completed, as required by MWRA’s Consent Order with MassDEP, by December 2003.

*11.11 2001 – Roosting Raft*

A raft was anchored in South Basin in late August by Natural Resources staff to attract daytime roosting gulls and draw them away from the North Basin. The raft remained for several years but was more of an attractant for a small population of Cormorants instead of gulls.

*11.12 2002 - Elevated Bacteria Response*

Elevated bacteria in samples taken at Cosgrove prompted additional measures to the harassment program on January 22, 2002. None of these samples exceeded the water quality standard of 20cfu/100ml but were higher than what had become customary which was majority bacteria-free along with intermittent low single digit samples.

- Additional harassment using a boat during daylight hours from Monday through Friday. Weekends added as necessary.
- Second boat will be added to evening program if gulls continue to resist harassment.

Sample results prompting action – January.

Date	2	3	7	8	9	10	14	15	16
Cfu/100mL	1	2	2	0	6	4	17	6	16

*11.13 2003 - MDC Becomes DCR*

Legislation is passed that merges the MDC with the Department of Environmental Management, creating the Department of Conservation and Recreation (DCR). The MDC Division of Watershed Management is now the DCR Division of Water Supply Protection, Office of Watershed Management.

*11.14 2004*

*Sampling moves to CWTP*

Fecal coliform sampling by the MWRA, which had been done since 1990 at the Cosgrove Intake in Clinton, is now done at the John J. Carroll Water Treatment Plant (CWTP) in Marlborough where primary treatment is employed. Samples taken at this location are close to the “point of disinfection” as required by the EPA water quality standards.

*NR staff counting at Roost*

Posting harassment program staff at the South Basin to count gull numbers and monitor bird movement towards the North Basin was discontinued. Natural Resources staff continued weekly counts.

*11.15 2007 - Airboats*

Hovercraft, which had been problematic in adverse weather and required constant repair, were replaced by two airboats, which operate on the surface of water and ice and are much larger than the hovercraft. The boats proved effective at moving birds but are somewhat difficult to operate, are extremely loud making communication difficult, and are difficult to transport and fuel. However, they have been useful tools and remain in use.



*Airboats harassing gulls*



*Airboat docked at Boat Cove*

Two devices were introduced for the detection of birds. An infrared scope was demonstrated by a vendor from the FLIR company. Unfortunately, birds were difficult to locate if at all. A radar for use on the boats was made available by Quabbin staff but for reasons that are unclear it was never installed.

#### *11.16 2008-2012*

##### *Gull research*

While the harassment program is very effective in reducing the number of gulls present within the harassment zone, and subsequently reducing the amount of fecal coliform being deposited near the intake structure, it does not address the number of gulls roosting elsewhere on the reservoir. Fecal coliform numbers in the southern end of Wachusett reservoir may be more than 10 times higher than those found in the north. Therefore, while the harassment program seems to address immediate water quality concerns specifically related to fecal coliform counts, little is known about the public health implications of 6,000 gulls roosting nightly on a water supply reservoir. In addition, there is very little information about the life history, movements, or feeding behavior of gulls in Massachusetts. In order to achieve a more comprehensive bird control program, it is important to identify other ways to control gull populations, either through restricting food sources, understanding roosting behavior or being able to eliminate roosting gulls from the reservoirs.

The research program was designed to address these questions:

1. What and where are the seasonal food resources for each gull species
2. What are the seasonal movement patterns between feeding and roosting sites, between reservoirs, and between reservoirs and "alternate roosts"?
3. What are the population dynamics of gulls in Massachusetts?
  - a. Where do they nest?
  - b. Sources of mortality
  - c. Lifespan
4. What are the responses of gulls to various harassment techniques?
  - a. Full-reservoir harassment
  - b. Increased harassment effort

Results of this study were published in a variety of publications. The study identified and assessed the foraging locations of gulls in central MA, looked at roosting behavior, and identified site fidelity to Wachusett Reservoir. Various parking lots were identified as regular food sources for gulls, and people regularly tossed food to gulls (“dedicated feeders”). People who frequented parking lots with large quantities of bread and related food to feed the birds. Efforts were taken to curtail the practice through public outreach and advocating for local ordinances. Two city ordinances (Worcester and Leominster) were changed that made feeding wildlife (gulls) a civil offense.

**Wait! Please don't feed the gulls.**



**They may be fun to feed,** but gulls are potential carriers of such dangerous bacteria as *Salmonella* and *E. coli*, and may also carry bacteria that can cause staph infections and stomach flu.

**Please don't feed the gulls.**

Gulls feed here and then roost for the night on Wachusett Reservoir and other water supplies, threatening the drinking water for more than 2 million people.

**Please help keep our drinking water clean.**

Walmart Store Management and the Massachusetts Department of Conservation and Recreation **thank you for your help!**

For more information, visit [www.mass.gov/dcr/gullstudy](http://www.mass.gov/dcr/gullstudy).




"Dedicated Feeder" at a commercial parking lot and DCR "don't feed" sign.

**H E L P !**




**HAVE YOU SEEN US?**

We have colored wing-tags with letters/numbers and bands on our legs.

Note that all birds have a silver federal band on the right leg and most birds have a colored band on the left leg.




Two ring-billed gulls tagged with yellow (top) and fluorescent green (bottom) colored tags.

Ring-billed gulls tagged with fluorescent orange (top) and fluorescent pink (bottom) wing tags.

**THESE GULLS ARE PART OF A RESEARCH PROJECT. EVERY SIGHTING IS VERY IMPORTANT INFORMATION.**

**PLEASE...**

if you see a tagged gull, let the researchers know by contacting Ken MacKenzie at [Ken.Mackenzie@state.ma.us](mailto:Ken.Mackenzie@state.ma.us) (508-792-7423 x313) or Dan Clark at [Dan.Clark@state.ma.us](mailto:Dan.Clark@state.ma.us) (508-792-7423 x215) with the **date, time, location, and wing-tag information.**

**Thank You For Your Help!**



Massachusetts Department of Conservation and Recreation  
Division of Water Supply Protection  
Office of Watershed Management  
Natural Resources Section  
[www.mass.gov/dcr/water](http://www.mass.gov/dcr/water)  
www.dcr.state.ma.us

**\*Please keep posted\***

Another study by the NR Section was to determine the seasonal movements and roosting behavior of gulls using satellite transmitters, wing-tags, and leg bands and monitoring their movements. Results showed that birds tagged at Wachusett Reservoir travelled near and far, some flying north to Nova Scotia and Newfoundland, while others flew south to the Carolinas, Florida, and even Bermuda.

**Food source reduction**

As a result of this research a variety of projects were completed to minimize the amount of food available to gulls in central Massachusetts. These initiatives included:



*Old bathtub feed container for livestock*

**Controlling gulls at agricultural sites:**  
Several different farms were identified as areas where gulls were accessing food being provided to livestock. Structures were erected on these farms that allowed livestock to feed but excluded gulls.



*Enclosed containers exclude gulls*

*Wire grid installed over sewage settling tank.*



**Controlling gulls at wastewater treatment plants:** Upper Blackstone Water Abatement facility was identified through the research as a location where gulls were regularly feeding on human waste. In response, stainless steel wires were installed at the facility to physically exclude gulls from the various settling tanks. Additional information available at [www.mass.gov/info-details/water-supply-protection-gull-study](http://www.mass.gov/info-details/water-supply-protection-gull-study).

#### *11.17 2009 - Pyrotechnic Launcher Upgrades*

Multi-shot Mossberg shotguns were added to rapidly launch Shellcrackers. The new equipment did not provide any advantage over the traditional single shot shotguns, as Shellcrackers occasionally lodged in the barrel requiring a check each time a shell was fired.

Guns used for launching pyrotechnics since the beginning of the program were cleaned and barrels replaced. Several of the gun barrels were not compatible with what was required for Shellcracker use although most had been in use safely for several years.

#### *11.18 2011 - Lasers*

Two penlight sized lasers, with outputs of 50mW and 200mW and a range of about one quarter mile, were acquired which produced a concentrated green beam of light that agitates birds but does not hurt them. They proved useful under low light conditions when birds were less responsive to pyrotechnics.

### 11.19 2012 - More Lasers

Two large flashlight sized *Hercules* lasers offering an output of 500mW with a range of approximately 1 mile were acquired, offering a much further reach across the reservoir than the penlight sized lasers.



### 11.20 2016 - Full Reservoir Harassment I

A pilot program of “Full Reservoir Harassment” was conducted to determine if birds could be completely moved from the reservoir (Figure 16). The program operated from October to November. Conclusion was that gulls can be kept off the reservoir however the effort required is extensive in both personnel and resources. A plan for conducting such a program was developed for the 1999-2000 season but was never implemented.

### 11.21 2017 - Full reservoir harassment II

A second Full Reservoir Harassment program is conducted. Operations begin in October and end in November. Results and conclusions are the same as the previous year. No plans were made to permanently institute the program.

### 11.22 2021 - SOP

Program operation has been improved by combining and standardizing written policies and procedures into one document: “Wachusett Bird Harassment Program Operations Manual.”



Figure 16: Full Reservoir Harassment Zones

### 11.23 2022 - Cosgrove Drainage Improvements

The “Austin” memorial deck drains for the collection and treatment of stormwater at the Cosgrove facility were installed in 2022, and named for retired head of Wachusett EQ, Patricia Austin. These are a long sought after solution to the potential contamination resulting from gulls roosting on the building and their waste entering the reservoir directly adjacent to the intake. Formerly open deck drains over the water were replumbed and connected to two drywells. Intake facility roof drains are connected to stormwater system and discharged out of basin along with other site drainage.



*Piping from Cosgrove deck*



*Drywell containing flow from deck drains*

## 12 Current Bird Harassment Program

### 12.1 Summary

The BHP has been a success by many measures. Bacteria exceedances are rare, costs have been reduced, the number of staff hours has been reduced, and safety has increased. Most importantly, there has only been one violation (1999) of the SWTR water quality standard since the first season of the program in 1993 (Figure 17).

Over the years, adjustments have been made, and new technology incorporated, but the overall approach to resolving the bird and bacteria problem remains consistent: harass birds out of the North Basin to the Roost in the South Basin.

Harassment consists of pyrotechnics launched from shore and the boats. Lasers are used when it is dark enough for them to be seen. Airboats are used during ice and water conditions to reach birds out of the range of shore launched pyrotechnics. The Roost is observed to record bird numbers as are landfills and regional food sources. MWRA staff take water samples each day for regulatory compliance.



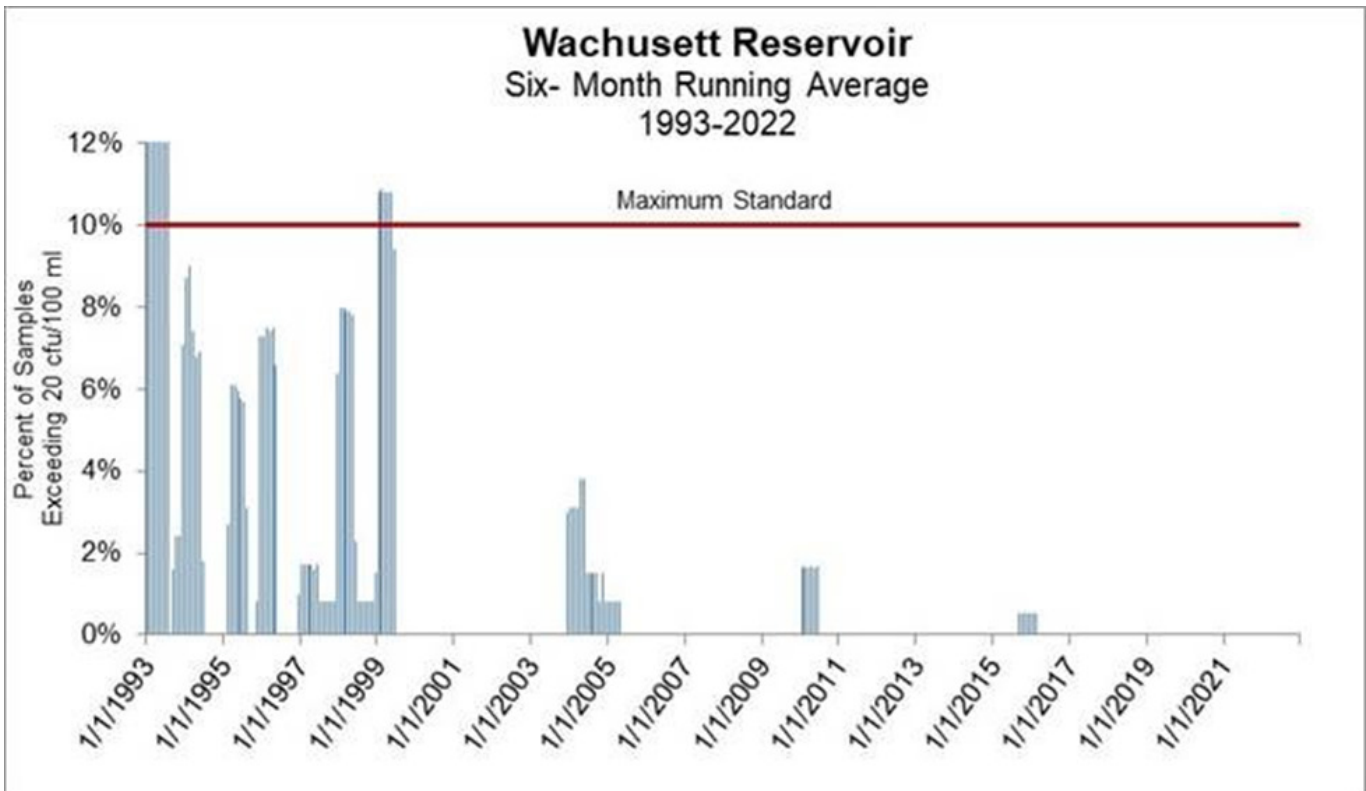


Figure 17: Wachusett Reservoir Fecal Coliform Bacteria Concentration Six Month Averages, 1993-2022

## 12.2 Management

Program management has been the responsibility of a succession of managers, all from the MDC EQ Section (now DCR-DWSP-EQ) including Ed Brank until 1992, John Scannell from 1992 to 2000, Larry Pistrang from 2000 to 2005, and Tristan Lundgren from 2005 to the present. Program decision making is based on input from the DWSP Division Director, Regional Director, Assistant Regional Director, EQ staff, NR staff and Office Support personnel.

## 12.3 Operation

The program continues to run essentially the same as it did during the first year. It is driven by the number of fecal coliform bacteria as reported daily by the MWRA, transect samples taken by the DCR, and the number of birds observed by BHP and NR staff in both North and South Basins. Daytime observations are made in the later summer to record bird numbers and activity. Active harassment occurs primarily in the fall and winter months. It is variable, increasing and decreasing in intensity from one shore staff to two shore staff and one or more boat crews. Days and hours of operation vary; in recent years it has operated two, three, or five days a week from 1.5 to 4 hours each evening. Shore personnel harass and collect data while boat personnel harass in communication with shore personnel. NR staff make weekly counts of birds at the Roost and continue to monitor the Fitchburg landfill and area food sources such as large commercial parking lots. NR staff also record observations of gulls and other nuisance birds during spring and summer months when the program is not operating. Additional data is collected from reservoir operations such as reservoir elevation and temperature. The program is a voluntary overtime opportunity offered to Wachusett staff.

## 12.4 Harassment

Many harassment methods and techniques have been tried since 1992 but the most effective remains pyrotechnics (*Bangers*, *Screamers* and *Shellcrackers*) launched from boats and shore along with boat presence. The addition of lasers as secondary harassment tools has proven quite useful. Lasers extend the time of day in which birds can be harassed. Pyrotechnics and lasers used in combination have been the mainstay of harassment. Several harassment methods were discontinued, such as distress call recordings, propane cannons, and imitation predators.

Lethal methods to control gulls have been used only a few times and only for reinforcement during partial ice conditions when birds were extremely reluctant to leave. It remains an option. Nesting birds have not been a problem for many years.

Locations at the North Basin where birds prefer to roost and thus where harassment is focused has largely remained unchanged: the Shallows, Midreservoir and Crescent Island.

### 12.5 *Equipment Improvements*

Data collection during the program was improved with the addition of iPads and ArcGIS applications. Other data sources used in reporting and analysis of the program were improved in this way as well.

Pistol launchers for pyrotechnics, both single shot and revolvers, wear out and were replaced several times. Shotguns as launchers had barrels replaced and two additional Mossberg multiple shot shotguns were added. Pyrotechnic explosives have remained the same throughout the program's history. One promising addition was a two-stage combination Screamer Banger rocket which increased the distance the explosive could be carried, but it was discontinued after a year.

Lasers were added as harassment tools. Different models of handheld lasers were purchased at different times. The first ones were small penlight type with a range of about a half mile, the second set were much larger, flashlight sized and had a longer range, about a mile. These lasers, while very effective, were difficult to maintain and broke after several years and replacing them with similar types was not an option as rules for their sale had changed. A third set was purchased but did not have as long a range.

Hovercrafts were discontinued in favor of airboats. Boats were upgraded with efficient and less polluting engines, heaters, and navigation technology. Docking and mooring facilities were upgraded to improve safety and operation. Boat crew safety was enhanced with the addition of "dry" survival suits which extended survival time. Spotting scopes were purchased to improve sighting birds and tracking their movements.



*Airboat Harassing Gulls*

### 12.6 *Reporting*

Accounting of the program is given in weekly and final reports. Each report uses data from several sources, most using an ArcGIS based application. Bird numbers and behavior are recorded by shore personnel, bacterial transect data is recorded by EQ personnel, official bacteria results, and reservoir levels are recorded by the MWRA, and Roost numbers are recorded by NR staff. This data drives the program and helps to evaluate the results.

## 13 Education/Outreach

Education and outreach are new aspects of the program initiated in recent years. Outreach includes annual notifications of program activities to abutting schools, administration, Clinton Fire Department, Clinton Police Department, and the Town Manager. Staff now offer to visit schools with an education program to both promote water quality education and program specifics. Signs summarizing harassment purpose and methods are posted at kiosks at entry points around the reservoir, such as the North Dike.

**dcr** Wachusett Reservoir Watershed  
Massachusetts 180 Beaman Street  
West Boylston, MA 01583  
(508) 792-7806



### Bird Harassment Program

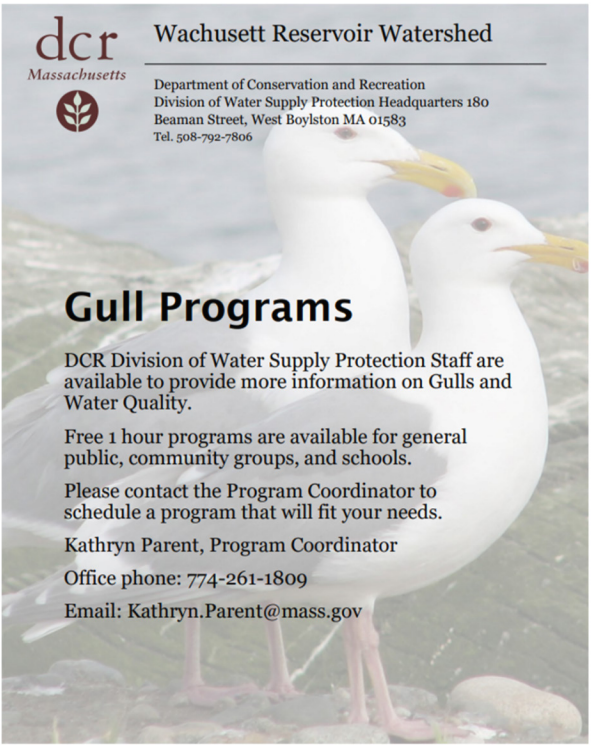

- DCR staff harass waterfowl with pyrotechnics and lasers to get them to leave the reservoir.
- The pyrotechnics are loud but not lethal and are launched from shore towards the water or from a boat.
- Up to 5,000 gulls may group together on the reservoir at this time of year to try to avoid predators.
- Gull feces contains bacteria and viruses that impact water quality.



**Please do your part and DO NOT FEED WATERFOWL**

## Public Advisory

**dcr** Wachusett Reservoir Watershed  
Massachusetts Department of Conservation and Recreation  
Division of Water Supply Protection Headquarters 180  
Beaman Street, West Boylston MA 01583  
Tel. 508-792-7806



### Gull Programs

DCR Division of Water Supply Protection Staff are available to provide more information on Gulls and Water Quality.

Free 1 hour programs are available for general public, community groups, and schools.

Please contact the Program Coordinator to schedule a program that will fit your needs.

Kathryn Parent, Program Coordinator  
Office phone: 774-261-1809  
Email: [Kathryn.Parent@mass.gov](mailto:Kathryn.Parent@mass.gov)

## 14 Future Issues

### 14.1 Harassment Technology

Future harassment utilizing Unmanned Aerial Vehicles (drones) may become a better harassment tool. Drones are already being used by the NR Section to count the numbers of birds in the Roost. Other harassment methods may use new audio or visual technology. Research on new methods will continue.



*Aerial view of Roost taken from drone*

#### *14.2 Population Trends*

A positive trend that has developed over the past several years is a decrease in the overall number of birds annually using the reservoir. Utilizing the weekly Roost counts as a rough comparison, the number of gulls at the Roost in 2004 was over 7,000 while in recent years it has been under 2,000. A decreasing number of birds on the reservoir translates into less resources necessary to operate the program.

#### *14.3 Challenges*

Operation in winter continues to be difficult. In order for harassment to be successful it must be brought to wherever the birds are, and the combination of ice and water present daily challenges to this task. Equipment operation and maintenance is problematic and harassment opportunities are lost when operation is not possible. Staff safety is of utmost concern. Program operation occurs mostly during cold weather months and great care is be taken to minimize risks. Current management includes having safety protocols when using boats; requiring additional boats for emergency response; mandating survival suit use; ensuring communication devices are functioning; and close cooperation with Ranger staff.



*Frozen boat launch area*

#### 14.4 *Climate Change*

Climate change appears to have affected the program. The period at which birds arrive in significant numbers has moved later in the year as fall becomes warmer, making it difficult to plan for active harassment. Reservoir ice over is becoming less frequent in winter, and the duration of ice presence has decreased, leaving patchy ice conditions to work with, creating more difficult operating conditions. A longer season without a freeze means additional resources and a more costly program.

## 15 Conclusion

From a time when thousands of gulls once routinely roosted each night near the water supply intake causing fecal coliform bacteria levels to reach over 300 cfu/ml to the present where several hundred gulls are seen as problematic and the water is bacteria-free the majority of the time, the bird harassment program has been one of ingenuity, adaptation and persistence.

The range of tools, tactics and methods that have been either tried or theorized over the years is extensive. From baffle curtains and explosives to airboats and helicopters it appears nothing has been left out.

The overall population of gulls at the reservoir has been greatly reduced most likely owing to the efforts to eliminate/decrease regional food sources and eliminate nesting.

Much time, effort and resources have gone into the development of the program and its operation over the years, but the positive results couldn't be clearer and the importance as a watershed protection program cannot be understated.

As the program continues to evolve more emphasis will likely focus on improving harassment tactics during winter weather, exploring remote operation, better tracking of birds at night, upgrading data collection along with continued efforts at further reducing food sources.

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## 17 Appendices

### Appendix A – Timeline

#### 1986

- Safe Drinking Water Act passed in 1974 and amended in 1986 is designed to protect the public from contaminated drinking water.

#### 1989

- Surface Water Treatment Rule (SWTR) designed to protect public health by reducing illnesses caused by bacteria and pathogens in drinking water. Requires filtration of public drinking water from surface water sources by June 1993 unless by December 1991 the system manager demonstrates it meets criteria for a filtration waiver.
- Eight source water criteria must be met to qualify for a waiver, one of which is coliform bacteria. A bacterium commonly found in bird feces.
- Fecal coliform testing initiated at Wachusett Reservoir and at Quabbin Reservoir in 1990 to evaluate compliance with the new water quality standards.

#### 1991

- MWRA system does not meet waiver criteria deadline.
- MWRA and MDC conclude that roosting gulls and other birds are the probable source of seasonally high fecal coliform concentrations detected in water samples taken at the Cosgrove Intake for the past several years.
- Bacteria Distribution Survey (transect sampling) initiated to document the relationship between the levels of bacteria throughout the reservoir and the seasonal variations in the population of gulls and geese.

#### 1992

- Gull/Bird Control Program planning and development begins with MDC staff from the EQ and NR sections along with a Technical Advisory Committee. Program evolves into the Bird Harassment Program.
- The program is divided into three components: 1) reduce regional food sources 2) eliminate the nesting population 3) move roosting birds from the north basin using harassment.
- Active harassment focuses on moving birds, mostly gulls roosting near the Cosgrove Intake area (North Basin) through the Narrows to the South Basin where they are allowed to roost.
- Harassment consists of launching pyrotechnics at birds from boats and the shoreline along with distress call broadcasts, and propane cannon explosions.
- **Bird Harassment Program first season (1992-1993)** begins in early September with observations of bird numbers and behavior at the North Basin. Gull numbers reported in the thousands.
- October 20: Active harassment begins. Boat use dropped after gull numbers decrease. Shore harassment continues.
- November 12: Number of gulls at North Basin increases and boat team deployed. Second boat added soon after.
- Late December: Reservoir starts to freeze then melts; 338 cfu/100ml recorded at Cosgrove. Harassment continues and bacteria numbers decrease.

#### 1993

- January 11: Last day of harassment from boat. Frozen shoreline at boat launch areas prevents further use.
- Shore harassment continues.
- Variable patchwork of ice and open water continues to attract gulls beyond effective range of pyrotechnics. Shore harassment ends January 25.
- Variable patchwork of ice and open water continues to attract gulls. Bacteria exceedances occur in absence of harassment.



- February 25: Reservoir freezes completely. Gulls leave area.
- October 4: Bird Harassment Program second season (1993-1994) begins. Staff observe and harass from shore only each afternoon until dark.
- October 12: Boat team added.
- October 18: Second staff added to assist with shore harassment. Bird numbers increase.
- November 8: Addition of second boat. Harassment successful.
- November: Harassment continues as bird numbers increase.
- December: Ice and open water problematic for harassment leading to bacteria exceedances.

#### **1994**

- January 17: Reservoir completely frozen. Bird Harassment Program second season ends.
- Spring activities extend harassment and attempt to eliminate nesting on Cunningham Ledge.
- August 1: Bird Harassment Program third season (1994-1995) begins with one staff person observing and harassing from the shoreline from afternoon until evening.

#### **1995**

- Early January: Boat use as necessary with dangerous winter conditions.
- Early February: Ice cover makes hovercraft necessary.
- February 15: Active harassment ceases then resumes on February 28 after two exceedances. Gull numbers high throughout March then drop in April.

#### **1996-1998**

- Program continues successfully with few exceedances. Core harassment method continues to be pyrotechnics launched from shore and boats. Hovercraft use during partial ice conditions.

#### **1997**

- Last attempt at nesting by a small group of ring-billed gulls. Eggs and nests destroyed.

#### **1998**

- Lawsuit seeking compliance with the SWTR initiated in US District Court: *EPA v MWRA On the Best Course Forward for MWRA's Drinking Water Program*.

#### **1999**

- Exceedances of the 20 cfu/100ml water quality standard for fecal coliform during the winter result in the first violation of the SWTR water quality criteria since 1993. Program adjusted to intensify harassment.

#### **2000**

- Decision issued in favor of granting a waiver from filtration citing the Bird Harassment Program as one reasons for affirming that filtration can be avoided.

#### **2001-2023**

- Program continues successfully without violations of the SWTR. Program consists mainly of harassment with pyrotechnics launched from shore and boats.

*Appendix B – Harassment Tools and Techniques*

**Harassment Tools and Control Methods – Tested**

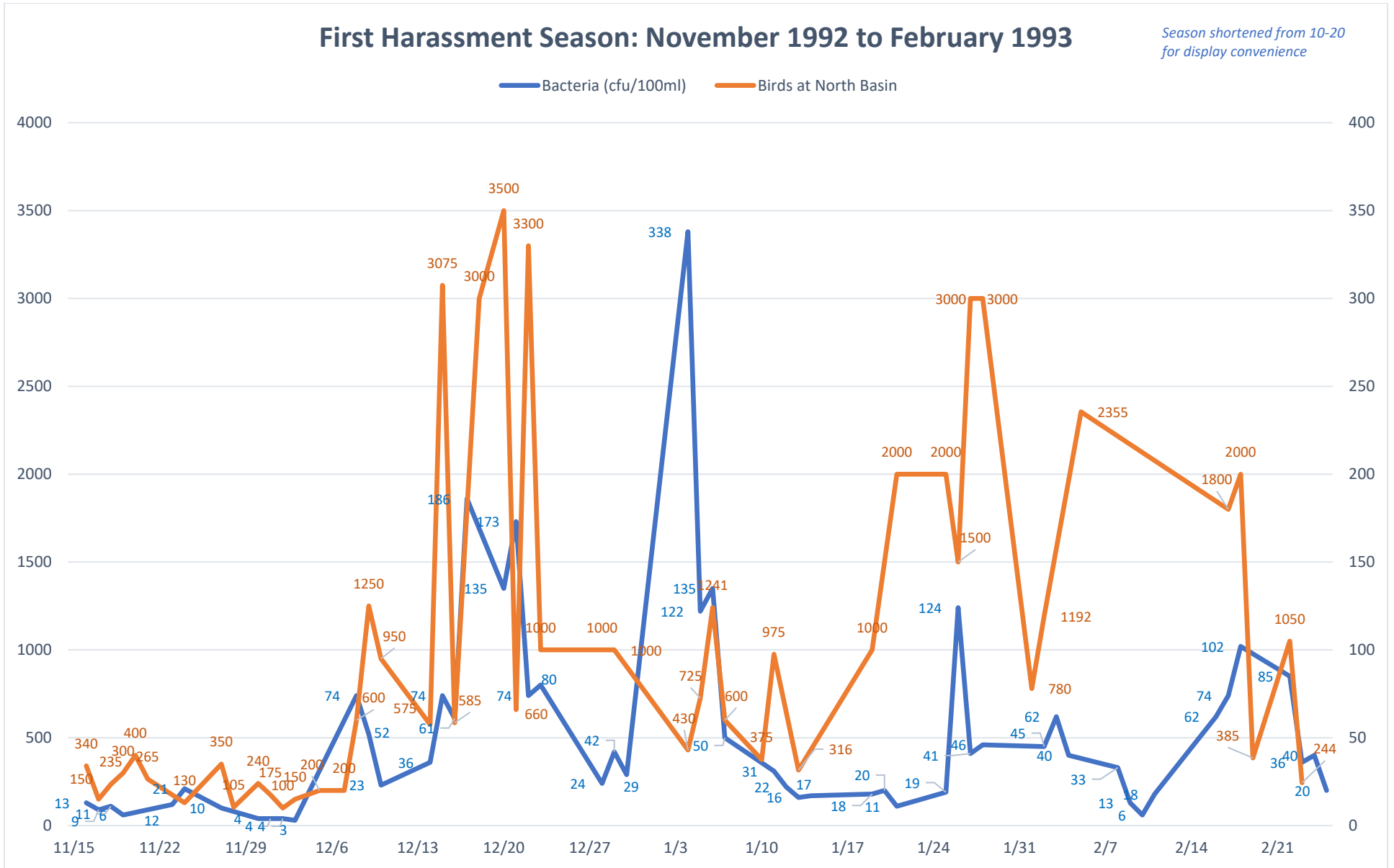
<b>Category</b>	<b>Tool/Method</b>	<b>Description</b>	<b>Effectiveness</b>
Auditory	Distress calls of gulls	Recorded, disturbing calls creates sense of alarm.	Low. Short period of time before birds return. Enhancement tried with commercial loudspeaker company.
Auditory Enhancement – Distress Calls	Distress calls of gulls	Utilize commercial loudspeaker company	Effective during three-day trial with rented equipment only in conjunction with pyrotechnics.
Auditory	Propane cannon	Creates loud disturbing sounds.	Moderate. Birds move but usually to another location on the reservoir.
Auditory	Pyrotechnics (Bangers, Screamers, Shellcrackers)	Creates loud disturbing sounds.	High. Explosion sounds, locations and directions can be varied. Mobile tool.
Behavioral Modification (short-term)	Create alternate roosting sites (not breeding).	Locate artificial device/raft in South Basin to attract birds from North Basin.	Low. Need to be larger. Attracts species other than gulls. Concentrates contamination.
Combination: audio/visual	Pyrotechnics and boat presence	Combines techniques aimed at moving birds away from the Cosgrove Intake.	High. Flexible based on number of birds and season.
Deterrent	Zero tolerance program for birds on reservoir	Full reservoir harassment pilot program in Fall 2016 and Fall 2017	High. But requires extensive resources.
Deterrent	Boat/hovercraft presence	Moves birds when close.	High. Birds move away from boat which can get close to them. Can chase birds to desired location. Serves as platform for launching pyrotechnics.
Habitat Modification	Install stormwater management system	Diverts contamination from sensitive areas.	High. Prevents contaminated runoff from birds roosting at intake from discharge to the reservoir.
Habitat Modification	Altering water level	Changes amount of surface area available for roosting and resting.	High. But has major ramifications for overall reservoir management.
Habitat Modification	Mow grass on dikes before seeds set.	Eliminates food source for geese	High. Food source is removed.
Habitat Modification	Remove vegetation from areas frequented by birds.	Increases visibility of roosting/loafing birds.	Low. Elevation of land still obscures

<b>Category</b>	<b>Tool/Method</b>	<b>Description</b>	<b>Effectiveness</b>
Lethal	Shooting (gun)	Eliminates individual birds. Creates frightened response.	Low. Done for reinforcement. Positive short-term effect only.
Lethal	Pesticide use (Avitrol)	Eliminates groups of birds. Creates frightened response if poisoned birds return to roost or breeding area in distress.	Moderate. Successful in eliminating breeding birds. Somewhat effective for roosting birds.
Physical Barrier	Netting/wire/monofilament grid	Prevents access for nesting or roosting. Visually disturbing	Moderate. Limited to small areas, subject to weather damage.
Physical Barrier	Wind energy Baffle	Installed across Narrows to interfere with surface water currents potentially containing contaminants.	Low. Effectiveness uncertain due to a variety of factors.
Physical Barrier	Fencing	Prevents geese from accessing areas adjacent to dikes.	Moderate: some groups respond others do not.
Population Reduction (long-term)	Nest and egg destruction	Eggs are shaken, punctured, or sprayed with an impervious coating and returned to nest.	High. High percentage of eggs don't hatch. Parent won't lay more eggs.
Population Reduction (long-term)	Eliminate or reduce regional feeding sites.	Develop policies and programs to reduce access to landfills, sewage treatment plants, and large commercial parking lots.	High. But long-term solution.
Visual	Inflatable ("scary eyes")	Mimics predators	Low. Birds become accustomed to them, subject to weather damage.
Visual	Coyote decoy	Mimics predators	Moderate. Some groups respond others do not.
Visual	Anchored raft	Attract to desired location away from undesired.	Low: Not large enough to make a difference. Cormorants frequented rather than gulls.
Visual	Flares	Sudden light frightens birds	Low. Some birds react. Most don't. not effective in large open area.
Vision Enhancement	Night scopes, thermal imaging, radar	Ability to track and locate birds in low light	Low: birds didn't show very well on the devices.

## Harassment Tools and Control Methods - Untested

Category	Tool/Method	Description	Reason not used
<b>Auditory</b>	Distress calls of geese	Recorded, disturbing calls creates sense of alarm.	Unknown
<b>Auditory Enhancement - Pyrotechnics</b>	Use of <i>Lark</i> as platform for launching pyrotechnics	Amphibious vehicle used by the military similar to a "Duck boat". Ability to launch pyrotechnics closer to roosting birds.	Only one available, deemed impractical.
<b>Auditory Enhancement - Pyrotechnics</b>	Obtain pyrotechnics from State Fire Marshall.	More powerful devices than commercially available.	Uncertain
<b>Auditory Enhancement - Pyrotechnics</b>	Obtain pyrotechnics or explosives from Fort Devens (local Army Reserve facility)	More powerful devices than commercially available.	Unknown
<b>Deterrent</b>	Remotely operated UAV (drone)	Moves birds when close.	Unknown
<b>Deterrent</b>	Remotely operated boat	Moves birds when close.	Unknown
<b>Deterrent</b>	Helicopter	Disturbs from large distance	Expensive, limited availability, dangerous if bird strike.
<b>Deterrent</b>	Plane	Disturbs from large distance	Expensive, rate discussed, no follow through.
<b>Deterrent</b>	Encourage predatory bird habitation with artificial nest creation	Frightens/eliminates other birds	Eagles have nested at reservoir on their own and have had a small effect.
<b>Habitat Modification</b>	Eliminate areas frequented by birds	Lower elevation of Shallows, Cunningham Ledge through mechanical or explosive means.	Uncertainty of effects on reservoir.
<b>Habitat Modification</b>	Plant trees and shrubs	Decreases available area for breeding and roosting	Difficult in the rocky areas frequented by birds.
<b>Lethal Enhancement – Shooting</b>	Shoot with crossbow or silencer	Eliminate individual birds without objectionable noise.	Unknown
<b>Physical Barrier</b>	Filter curtain	Install around Cosgrove to prevent infiltration of contaminants.	Unknown
<b>Visual</b>	"Hi-Taka" effigy, imitation hawk	Imitates predator with wing fluttering action. solar cell activation.	Unknown
<b>Visual</b>	"Birdmaster tether" hawk-like kite	Imitates predator	Unknown
<b>Visual</b>	"Mazzo-Missile" imitation bird	Propane powered device that shoots an effigy up 30' pole imitating a fluttering bird in distress.	Unknown
<b>Visual</b>	Strobe light	Frightens birds	Unknown

Appendix C – First Harassment Season: Gulls at North Basin and Fecal Coliform Bacteria at Cosgrove



## **Bird Harassment Program**

### **General**

The Massachusetts Department of Conservation and Recreation, Division of Water Supply Protection, Office of Watershed Management manages the Wachusett Reservoir and its watershed to provide safe drinking water to 3.1 million people in 53 communities primarily in metropolitan Boston. The Division's Environmental Quality Section implements a comprehensive Bird Harassment Program (BHP) to minimize fecal coliform bacteria and pathogens in the water along with the assistance of the Natural Resources Section.

This program is specifically designed and operated to maintain compliance with the filtration avoidance waiver granted to the MWRA under the Federal Surface Water Treatment Rule. The MWRA manages and maintains the treatment and distribution facilities of this surface water supply.

The Wachusett Reservoir is a large open body of water which attracts waterfowl, primarily gulls, ducks, and geese, both transient and resident, however, bacteria and viruses from the feces of these birds is a serious water quality problem. Gulls represent the primary threat, followed by geese then ducks. According to a study published in [Applied and Environmental Microbiology](#), by Alderisio KA, DeLuca N, December 1999, gull feces contains, on average, 368 million fecal coliform units per gram of waste while goose feces contains 153 million and, according to a study published in the [Journal \(Water Pollution Control Federation\)](#) March 1962, duck feces contains 33 million.

These birds typically spend the day feeding wherever a food source is readily available such as landfills, dumpsters, and commercial parking lots, then come to the reservoir to roost overnight. The number of birds roosting depends on what time of year it is and ranges from several hundred to several thousand. Beginning in late summer and continuing through early winter birds become more numerous and as smaller bodies of water throughout the region freeze more birds use the reservoir, usually the last to freeze, and thus the only place available for roosting.

The Bird Harassment Program operates full time during this period, utilizing a variety of harassment tools and techniques to move birds from the North Basin, where the Cosgrove intake is located, to the South Basin where roosting is tolerated. A typical season for these activities begins in September and runs until the reservoir freezes, resuming after it melts and continuing until some point in April.

### **Harassment**

As the number of birds on the reservoir increases, they are monitored and prevented from congregating and roosting at the North Basin through the use of pyrotechnics, lasers, and the presence of boats. The most active time of day for this is from the late afternoon until dark when birds arrive at the reservoir for the night, although birds may be present at any time during the day. The birds are directed through harassment to the southern end of the reservoir where contamination is not considered a threat.

Generally, harassment is incremental, intensifying as the number of birds present increases and the response to harassment decreases. The initial phase of the program involves one staff member (Shore 1) observing birds and harassing with pyrotechnics and lasers from various locations throughout the North Basin shoreline. The number of days per week the program operates relates to bird and bacteria numbers. While the program may start at any time during the day, it usually begins in the late afternoon and runs until just after dark.

All activity is recorded by individual staff on a tablet using an ArcGIS Survey 123 program. If harassment with only one staff person becomes ineffective another is added (Shore 2) to assist. Shore personnel are positioned opposite each other on the shoreline at the Greenhalge Point and Gate 40 areas but move to other locations as necessary. If this arrangement becomes ineffective, a boat crew is added. The crew consists of a boat operator and a pyrotechnic shooter (Operator, Shooter). The crew harasses with pyrotechnics and the boat itself. Shore personnel harass with pyrotechnics and lasers and record data on tablets.

In addition, Natural Resources staff monitor South Basin for roosting birds as periodically, tallying the number of birds present at various times and any movement.