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# An Education and Monitoring Program for an Ongoing Estuarine Habitat Restoration Project

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# AN EDUCATION AND MONITORING PROGRAM FOR AN ONGOING ESTUARINE HABITAT RESTORATION PROJECT

A Final Report to

The New Hampshire Estuaries Project

Submitted by

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## Executive Summary

South Mill Pond, a tidal pond-like estuary and the study area for the present project, has suffered from a variety of environmental problems as the City of Portsmouth developed, including major watershed changes, combined sewer overflows, runoff from city streets and parking lots, and fill projects. Several years ago, the City initiated a long-term project to re-direct sewage away from the Pond to the City's wastewater treatment plant. In 2001, scientists from the University of New Hampshire joined with the City, eighth grade students and teachers from the Portsmouth Middle School, and local volunteers to construct experimental shellfish reefs and salt marsh habitat in the Pond.

Our project was designed to allow sixth grade students to participate in the overall community-wide program of restoring South Mill Pond. It had the dual goal of education and monitoring an ongoing habitat restoration project, and it involved approximately 160 sixth grade students at Portsmouth Middle School.

The education component consisted of teaching lessons on the ecology of coastal waters, how scientists study nature, and several biology topics, including identification and ecology of birds. South Mill Pond, which is located directly across from the Middle School, was the focus of most lessons. It was also the site for the monitoring component of the project, which involved observing, identifying and recording data on birds in and around the Pond.

Bird monitoring was conducted from March through June 2003, with an average of two observation trips per week conducted by the classes involved. Each observation team consisted of four to six students and one or two adult volunteers, who in most cases were parents of students in the classes. Environmental data and bird observations were recorded on standard data forms. A total of 1,079 birds were observed in or near South Mill Pond during the 3-month project. About 30 different species were recorded.

Both goals of the project were accomplished in substantial ways. Sixth grade students participated in an extraordinary, hands-on science project and were given the opportunity to work with professionals. The unique curriculum and lesson plans included a student handbook on the ecology of the Pond. For nearly all of the science topics covered – including photosynthesis, food webs, pollution, habitats, and others – the focus was on how they related to South Mill Pond. This made all of the lessons much more interesting and relevant.

We were overwhelmed at times by the amount of interest in this new ecology unit and bird-monitoring project. Clearly, there is an audience in Portsmouth interested in the restoration of South Mill Pond. And because of this project, Portsmouth Middle School sixth grade students are now among that group.

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## Introduction

South Mill Pond is really not a "pond" but an estuary where freshwater mixes with saltwater from the ocean. It is part of the Piscataqua River watershed of Portsmouth, New Hampshire. Early maps and observations suggest South Mill Pond was a combined salt marsh-mudflat ecosystem (likely with shellfish) prior to settlement of Portsmouth in the 1600s. In those days, people swam and canoed in the Pond. But in the late 1800's, things began to change. That was when inside plumbing came to Portsmouth, and sewage and run-off from new roads were dumped into the Pond.

In addition to changes caused by pollution, the Pond has been altered by various kinds of construction projects. The most conspicuous is a filled causeway supporting Junkins Avenue, which split the Pond in two portions, an inner pond and an outer pond. Currently, two large open culverts connect the two ponds and a tide gate on the eastern end connects the entire system to tidal waters leading to the Piscataqua River. Development around South Mill Pond, probably built on salt marsh in many areas, has been extensive: a city park, homes and city hall, including the police station, surround the outer portion. A city park, parking lots, recreation areas with tennis courts and ballparks, and the Portsmouth Middle School, border the inner portion.

Centuries ago, South Mill Pond was a place where clean freshwater from a mostly forested watershed mixed with Atlantic Ocean water. It was a healthy estuary providing habitat for a diverse array of life - from the tiniest phytoplankton and zooplankton, to shellfish, fish, and birds. Today, however, the "freshwater" that feeds South Mill Pond is runoff from parking lots and streets sometimes mixed with sewage. These changes have produced a Pond with problems.

One of the major environmental issues with South Mill Pond concerns combined sewer overflows during heavy rain events. This has resulted in a build up over many years of organic matter on the bottom and foul odors that sometimes come from the Pond. The City of Portsmouth is in the middle of a long-term re-sewering project that will eventually route sewage wastes from the area to the City's treatment plant. This should greatly reduce the overall pollution going to the Pond.

In 2001, the University of New Hampshire joined with the City, Team Piscataqua (eighth grade students and teachers at Portsmouth Middle School), and local community volunteers to initiate a 1.5-year ecological restoration project that was jointly funded by the National Oceanic and Atmospheric Administration's Community-Based Habitat Restoration Program, the Gulf of Maine Council for the Marine Environment, the Greater Piscataqua Community Foundation, and the Wal-Mart Foundation (Burdick et al. 2002). This project resulted in construction of several experimental shellfish (mussels and oysters) reefs and salt marsh habitat, and enhanced tidal flushing of South Mill Pond.

Noticeable improvements in the Pond were documented by the UNH-coordinated project. During this project, it was also noted that citizens familiar with bird use of the area reported that bird numbers in and around the Pond seem to have been increasing over the past several years. However, no data existed on bird use of the area. Our project was designed to provide such data and to involve sixth grade students in the process.

## **Project Goals and Objectives**

Overall, our project was directed at "Outreach Action Plan, EDU-5: Support for volunteer organizations active in water quality, habitat or other estuarine watershed natural resource issues" in the New Hampshire Estuaries Project Management Plan. One of the expected benefits of such activities mentioned in the Management Plan (NHEP 2000, p. 8-22) is "Volunteers engaged in environmental conservation, monitoring, and educational work make substantial contributions to raising public awareness and protecting and improving environmental quality."

Our project had the dual goal of education and monitoring an ongoing habitat restoration project. It consisted of seven major work tasks: develop curricula and lesson plans, conduct lessons, purchase supplies, conduct bird monitoring, data synthesis, project partner coordination, and media outreach.

## **Methods**

### Education Activities

Curricula (Appendix A) and lesson plans (Appendix B) were developed based on the current sixth grade NH science standards and relevant to the bird monitoring activities of the project (see below): the scientific method; birds and their basic life processes; ecology and identification of phytoplankton; consumers; and photosynthesis and its ecological importance.

The ecology of estuaries in general and South Mill Pond in particular was a central theme for most of the lessons. An ecology student handbook (Appendix C) was developed as a primary text. All students were also given in-class instruction in field protocol techniques involved in the bird monitoring trips (see pp. 15-16 in Ecology Student Handbook, Appendix C). The project also had a language arts component where students completed a written research paper that involved various aspects of the writing process. Details on how the educational activities were conducted are given in the Results and Discussion section below.

### Bird Monitoring Activities

The bird-monitoring component of the project was designed to provide UNH with quantitative data on overall bird use of South Mill Pond, and to test the hypothesis that the same number of birds would visit the inner pond (sites 1 and 2 on Fig. 1) when compared to the outer pond (sites 3 and 4). The overall study design was used to demonstrate to the students how scientists study nature.

To accomplish both objectives, the Pond was divided into four areas (referred to as sites) of approximately equal size and establishing a permanent observation site in each area (Fig. 1). One group of four to six students with one or two adult volunteers visited each of the four observation sites at the same time (between 12:30 pm and 1:45 pm) for an average of two days per week from March 28 to June 19, 2003.

Students were trained to identify the most common bird species in the area by a NH Audubon Society volunteer (see pp. 17-22 in Ecology Student Handbook, Appendix C). Each student carried a field notebook (Appendix D), illustrated bird identification field guide and a bird monitoring data sheet (Appendix E) into the field.

Upon arrival at the observation site, data were recorded on environmental conditions relevant to bird activities. Each team then observed, identified, and counted all the birds in their area for a 10-minute period, recording all data on the data sheet. During the next 10-minute period students would spread out and find a comfortable spot to record personal observations and drawings in their field notebooks. This general protocol was based on Dionne et al. (1999) and Brant monitoring guidelines (2003) web-published by the Qualicum School District in British Columbia ([www.sd69.bc.ca/~brant/Curriculum/Ch8.html](http://www.sd69.bc.ca/~brant/Curriculum/Ch8.html)).

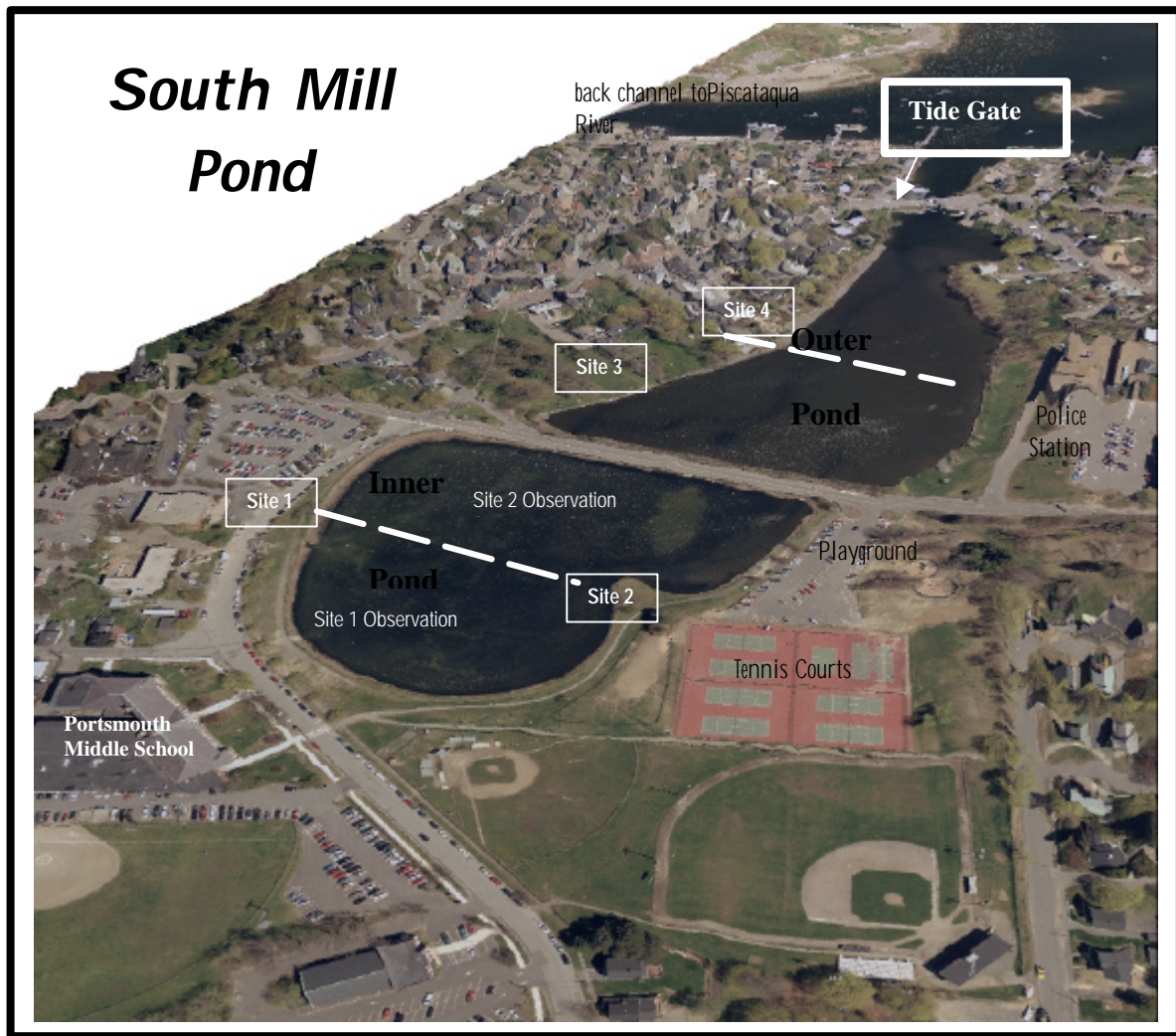


Fig. 1. South Mill Pond study area, showing four bird observation sites, residential and commercial development around the Pond, and the location of Portsmouth Middle School.



## Results and Discussion

### Education

Classroom activities were supervised by Ms. Andrea Bishop, sixth grade science teacher at Portsmouth Middle School (see Appendix F for a calendar showing all classroom sessions and bird monitoring activities). The following individuals prepared and conducted class sessions.

Ms. Candace Dolan, education specialist with the New Hampshire Great Bay Coast Watch Program, presented lessons on phytoplankton in estuaries, including identification and ecology. Candace brought in field microscopes and taught students how to identify phytoplankton samples from a nearby location. Ms. Karen Acerno, biologist with the New Hampshire Audubon Society, taught lessons on bird ecology and identification, with an emphasis on those species occurring in coastal New Hampshire. During four visits to the school, Candace and Karen each presented eight sessions involving 160 sixth grade students. Dr. Ray Grizzle, zoologist at the University of New Hampshire, presented two lessons (eight visits to the school for a total of sixteen sessions) on the history of South Mill Pond and introductory ecology.

Perhaps because South Mill Pond is located so close to the school, we found that students developed a sense of ownership to the Pond and the restoration process. Students at this age are excited about making a real difference in their community, and the more knowledge they gained on the pollution problems of the Pond the more passionate they became to "fix" it. Of particular interest to the students (and adults), was learning that there is a tide gate and how it affects the health of the Pond. Over the past decade or so, using the tide gate to maintain high tide in the Pond for several days at a time resulted in an unstable system with few living organisms in the sediments. If the gate is closed long enough, oxygen in the water is used up, killing fish and invertebrates in the Pond. Invertebrates such as worms, crustaceans, and mollusks that live in bottom sediments constantly mix and aerate them, contributing in the long-term removal of organic matter from the sediments. If these creatures are killed, then the entire food chain is altered and more foul odors are produced. UNH scientists contend that the long-term solution to the odor problem—and the overall restoration of South Mill Pond—must include better management of the tide gate. After learning this, students brainstormed ways they could help educate the community about the tide gate. As a result of student interest in the tide gate, a note card fundraiser was initiated by a parent volunteer. One in-class activity involved students drawing their "Perfect" South Mill Pond. These drawings were copied onto note cards with a message on the back explaining the use of the tide gate. Note cards are to be sold in downtown shops. Within three months, our students have already begun their own community education program.

During a class discussion on how to deal with environmental issues a sixth grade student exclaimed to the class that if she could do something to help clean-up South Mill Pond her entire life would be worthwhile. Dramatic as it sounds now, and did at the time, her response shows a typical passion many young people develop for community programs. The majority of the students who signed the Science Class Contract (see pp. 2 Ecology Student Handbook, Appendix C) took their "jobs" seriously and continually commented on how important they felt their work was to UNH scientists. Of course, students loved their "outdoor classroom" (even when it snowed or rained!) and seemed

to show a genuine interest in the overall study of South Mill Pond's plant and animal habitats.

The unique curriculum that was developed using South Mill Pond to illustrate the major lesson topics was invaluable for classroom discussions. Although requiring a lot of extra time to initially develop, the Ecology Student Handbook (Appendix C) was very important to the success of the course. One of the unique features of the Handbook was a Glossary (see pp. 36-39) with terms taken from our new *Environmental Science* textbook and then adapted to illustrate their importance to South Mill Pond. UNH scientists provided us with the information needed to specifically adapt the terminology to our needs.

One goal of Andrea Bishop and Teri Grizzle was to take advantage of this first year participation by the professional partners by learning as much as possible from the experts. With our limited knowledge on the history of South Mill Pond and the ongoing restoration program, it was exciting to observe how each guest speaker would re-teach topics in a slightly different way and build upon concepts presented earlier. Students were fortunate to be given this opportunity to interact and question scientists with different background areas of expertise but a common interest in South Mill Pond.

### Bird Monitoring

A total of nineteen field days occurred between March 28 and June 19, 2003 (Appendix F). A total of 1,079 birds were observed in and around South Mill Pond during this time (see Appendix G for raw bird count data). Total birds observed per day ranged from 19 to 125, and averaged about 65 per day (Fig. 2).

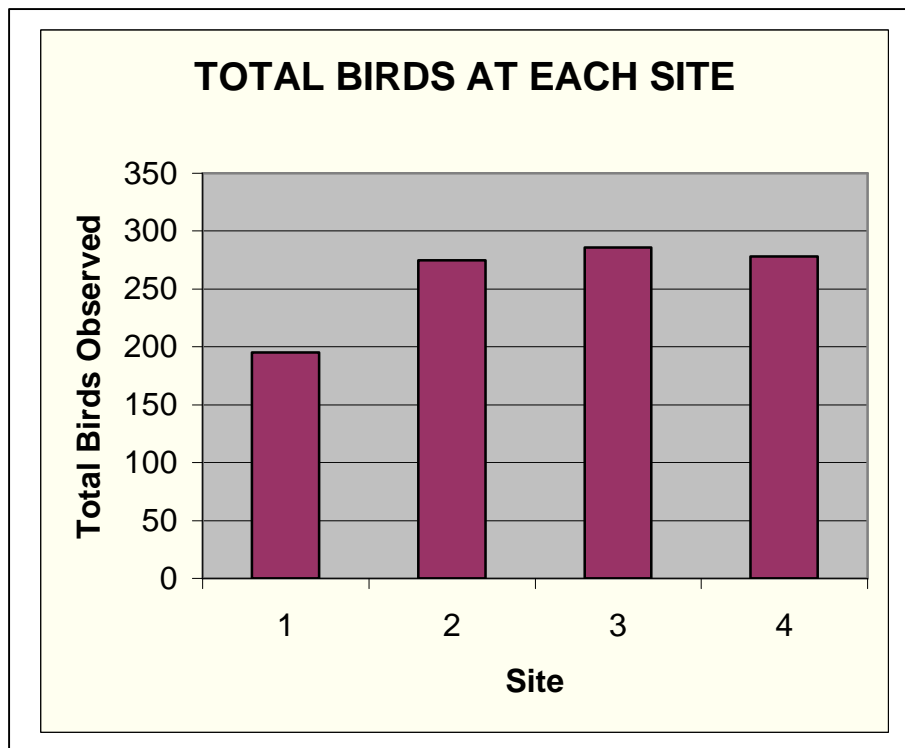


Fig. 2. Total birds observed at each of the four observation sites for the duration of the 3-month study.

The hypothesis that the same number of birds would occur in the outer pond (sites 3 and 4) compared to the inner pond (sites 1 and 2) was not supported by the total bird counts (Fig. 3). A total of 580 birds were counted at sites 3 and 4 in the outer pond compared to 499 at sites 1 and 2 in the inner pond. Although other causes could be involved, these data suggest that the more polluted inner pond has less bird activity, especially site 1. It will be interesting to see if the total bird distribution patterns change as restoration of the inner pond progresses. When considering the kinds of birds observed, it was found that gulls were by far most common, followed by crows, ducks and sparrows (Fig. 4). Surprisingly, the data show fewer wading and swimming birds than we expected to see. In past years, swans were commonly observed in the Pond but during our study none were observed.

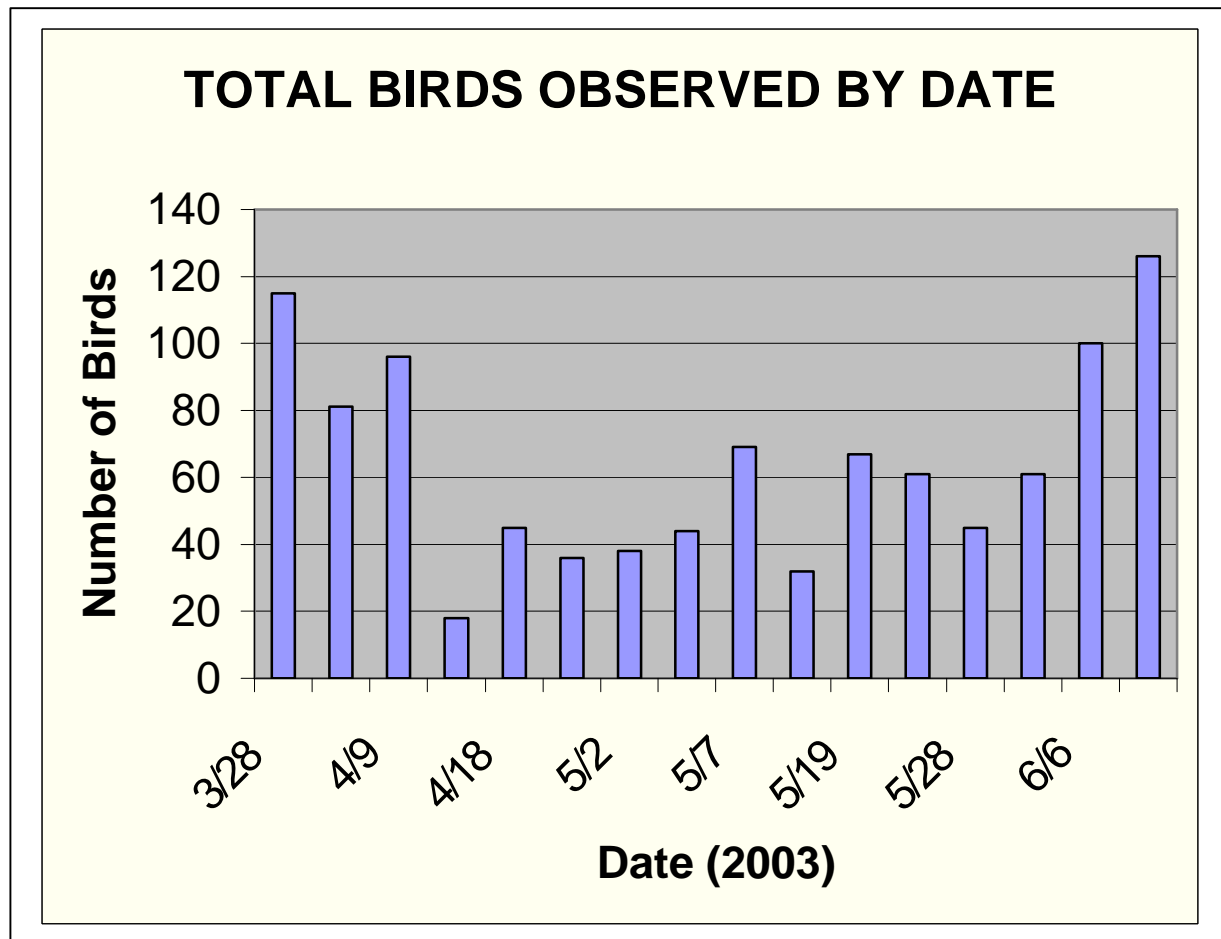


Fig. 3. Total birds observed at all four observation sites by date.

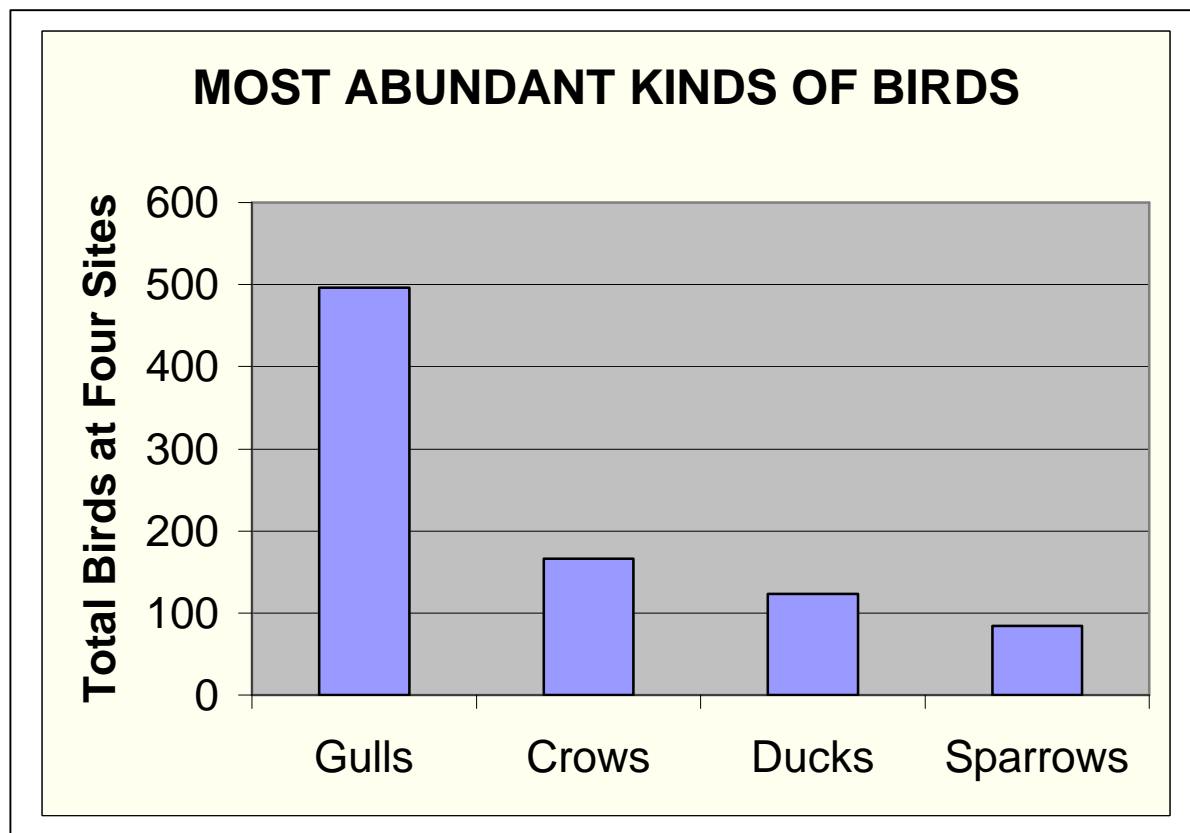


Fig. 4. Total observations at all four sites for the duration of the study of the major kinds of birds.

#### Project Partner Coordination and Media Outreach

As project manager, Teri Grizzle coordinated activities and schedules of all parties involved in the project, including PMS staff, professional volunteers (UNH scientists, Great Bay Coast Watch volunteers, and NH Audubon Society), and field volunteers. Various project meetings with partners were held throughout the program, including training meetings with adult field volunteers. Volunteer interest was overwhelming, with more parents interested than could be accommodated at times. Press coverage of the project (Appendix H) resulted in three local newspaper articles. Scientists from UNH have included the project in conference presentations in New Hampshire and Canada, and one presentation is scheduled for Hawaii in March 2004.

## **Conclusions**

We feel that both educational and monitoring goals were achieved in substantial ways. Approximately 160 sixth grade students at Portsmouth Middle School (PMS) were taught lessons and received "hands-on" experiences in a real science project in collaboration with scientists from the University of New Hampshire and the New Hampshire Audubon Society. When designing the program, we underestimated the enthusiasm of students and just how much data 161 budding, young scientists can collect! Our data represents the first such survey of bird use of South Mill Pond, and will serve as a baseline for future monitoring programs as the Pond continues to be restored.

We were overwhelmed at times (as the appendices indicates) by the amount of interest in this new ecology unit and bird-monitoring program. Clearly, there is an audience in Portsmouth interested in the restoration of South Mill Pond. This project has led to three others: the publication of a student science journal (excerpts in Appendix K); a "Perfect" South Mill Pond note card fundraiser, initiated by a parent volunteer, using student artwork for community education (Appendix L); and inclusion of a visit to South Mill Pond, Site 3, on the annual Portsmouth Summer Garden Tour. Because of the garden tour, a printed brochure highlighting Portsmouth Middle School's participation in this community restoration project was created (Appendix M). Dave Burdick and Ray Grizzle included our bird-monitoring project in the brochure.

We learned first hand how engaging volunteers does raise public awareness. So many individuals are working hard to not only restore South Mill Pond but also to make it better known, understood, and appreciated. Without question teachers and parents agree that this proposal provided our sixth grade students with an experience they are likely to always remember.

## **Recommendations**

Projects of this kind require a substantial amount of time and energy on the part of teachers and volunteers. This should be recognized and planned for early on. It required much more time than originally planned. Strong volunteer interest and involvement were critical to the project, but coordination of the volunteers consumed a considerable amount of time. Teachers typically do not have the time required to do these kinds of activities, so preliminary planning and allocation of work tasks is essential.

Because of the success of this project, it is recommended that a long-term comprehensive program be established at Portsmouth Middle School that involves as many students and teachers as appropriate in the ongoing restoration of South Mill Pond. Such an undertaking would require the continued guidance of principal John Stokel. If this was done, sessions longer than the 3-week period used in this project should be scheduled to provide the students with a more in-depth experience.

Finally, the public response to involving middle school students with the restoration project was encouraging. During the Portsmouth Garden Tour (Appendix M), visitors came to Site 3 with many questions and comments showing not only interest in the restoration but also support for Portsmouth Middle School students being involved in important hands-on science. To build on this interest in the future, a parent involvement program could be organized through the school.

## Acknowledgments

This project was the result of the hard work of many individuals. Portsmouth Middle School staff involved in the project included Andrea Bishop, sixth grade science teacher, and Teri Grizzle, the project coordinator. Karen Acerno (NH Audubon Society), Candace Dolan (Great Bay Coast Watch), and Ray Grizzle (UNH) donated their time to prepare lesson plans and provide much needed information for curriculum development. They also visited our classroom many times throughout the three months to conduct lessons. Dave Burdick, Jamie Adams, and Jennifer Greene from UNH contributed valuable knowledge, curriculum materials, and other information on South Mill Pond. Ray Grizzle also gave valuable time to help prepare this final report. From the beginning, we had support from our principal, John Stokel.

We thank the many parent and community volunteers (Appendix I) for their participation in nineteen field days. Their participation and enthusiasm was essential to the project. The community volunteer program of Heinemann Press in Portsmouth allowed several of its employees to donate over twenty hours of time to participate on field days.

Major funding (\$5,725) was provided by the Local Grants program of the New Hampshire Estuaries Project. We thank Jennifer Hunter and Dave Kellam of NHEP for their encouragement and support. Supplemental funds (\$950) were supplied by a Community, Higher Education & School Partnership (CHESP) grant from Portsmouth School System's Community Service and Learning Program.

Finally, we acknowledge all 161 sixth grade students (Appendix J) involved in the project. Their enthusiasm and observations while collecting data far surpassed expectations. A staff of 18 sixth-grade student volunteers donated their own time during school, after school, and at home, to create the students' South Mill Pond science journal (Appendix K). They served as typists, editors, and artists who were involved in major decisions concerning contents, cover page, title page, chapter layout and design.

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