Opportunities and Challenges for the Advancement of Citizen Science Programs

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Submitted By:

Keyla Arnal
Sarah Doyon
Erin Ellsworth
Jason Sansoucie

Sponsoring Agency:

The Museum of Science, Boston, Massachusetts

Submitted To:

Project Advisors:

Hossein Hakim
Malcom Ray

Project Liaison:

John Pickle

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Abstract

The goal of this project was to conduct a comprehensive study of mature Citizen Science programs to develop guidelines that will be helpful for less developed programs. Through in-depth interviews and research of many organizations, their various methods of data collection, archival and dissemination were studied and evaluated to gauge the possibilities for current Citizen Science programs. This report, in conjunction with the developed guidelines, provides less developed Citizen Science programs with new ideas for the advancement of their organizations.

Executive Summary

Each and every day, volunteers from various programs around the world offer their time and efforts to the scientific community. Prior to these programs, the amount of environmental data available to scientists for analysis was seriously constrained. A limited number of scientists can only collect a limited amount of data; therefore, the result would be a small quantity of high quality data. These programs, where citizens act as scientists to collect important environmental information, have become a main factor in the contributions to the scientific community. For example, *BirdSource*, a bird monitoring organization, annually holds a program called the Great Backyard Bird Count. Through this program, participants monitor and document bird population and migration across the continent. In 2005 alone, tens of thousands of volunteers reported more than 6.5 million birds from over 600 species in just four days during February.[1] With this information, scientists are able to analyze the information and create maps that document types of birds, as well as where and when they are migrating, proving that volunteers have plenty to offer to the world of science.

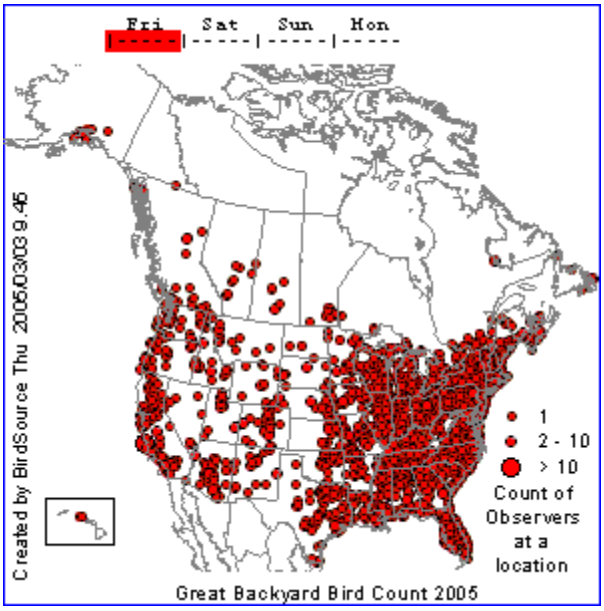

Figure 1: Map of bird migration in North America

Citizen Science programs involve activities that allow participants to monitor, track, and respond to environmental issues that are necessary for scientists to gain a better understanding of our surroundings. A program may consist of the general public, government, and/or industry volunteers. Regardless of education and experience, and with proper training and a commitment to accuracy, citizen scientists can assist with

[1] The Great Backyard Bird Count [Internet] [Cited 2005 April 27] Available at http://www.birdsource.org/gbbc/summary.html

environmental research and be a valuable asset to the scientific community. Citizen Science provides participants with a better understanding of the environmental issues that affect the world daily.[2] This plan allows essential gaps to be bridged between science, the community, and the environment. By utilizing the data collected from previous studies, scientists will be able to respond to environmental problems more efficiently.

Citizen Science programs can be applied to a broad range of issues. Some focal points of these programs are monitoring of climate and weather, animal migrations and interactions, and phenology. This information is vital to the efforts of scientists attempting to appreciate and comprehend the changes in our surroundings. Data collection methods vary from program to program. However, a common thread in all of the programs is the hope to learn and exchange information, to observe changes over time, and to educate the public on environmental concerns.

The main issue currently facing Citizen Science programs is that there is a lack of communication among them. Underdeveloped programs are not informed on the successful concepts and ideas that the advanced programs might have, such as: advertisement techniques, data collection methods and activities, and data dissemination systems. Due to the lack of communication between programs, many of the less developed programs have not been introduced to the resources and ideas that make the mature programs successful. In addition, many organizations face the challenge of how to make the collected data and information from their programs accessible to scientists for analysis.

The goal of this project was to assess the opportunities and challenges for the advancement of Citizen Science programs. A comprehensive study of mature Citizen Science programs throughout North America was conducted in order to develop guidelines and recommendations that could be helpful for less developed programs.

The team first carried out in-depth interviews with twelve different programs to identify and classify the various types of data being collected by Citizen Science programs in North America, as well as advertisement and marketing techniques used by each. These interviews provided a list of activities and data collection possibilities for the less developed organization. From there, we conducted interviews with scientists from

[2] Beaver Creek Reserve [Internet] [Cited 2005 April 26] Available at http://www.beavercreekreserve.org/

Boston University and Brandeis University to identify the research areas that will benefit from the data collected by Citizen Science programs. This was important to our project because we found that organizations were much more successful when the volunteers knew what their data was being used for. When participants understand that they are contributing to a bigger picture, they have much more eagerness to become involved.

Through communication with our sponsor and firsthand experimentation, the team also identified innovative methods of digital imagery data collection and analysis. Techniques such as picture post photography, time-lapse film and filtered lenses, which have not yet been used by Citizen Science programs, will be of great assistance in observing changes over time in our environment. In addition, software programs such as CyberTracker, a GPS tracking device, and digital imagery analysis offer free and easy ways to transform the raw collected data into vital environmental information.

A number of interviews were then conducted to examine various types of databases used by Citizen Science programs throughout North America. From these interviews, and with further research, we were able to distinguish the positive and negative characteristics of various databases. With these results, a computer-based interactive decision tree was produced which was designed to assist Citizen Science programs in deciding the most appropriate database based on their personal preferences and limitations towards cost, maintainability, user-friendliness, and other important characteristics. Our hope is that this decision tree will offer a more simplistic in-depth look at the possibilities for advancement of data dissemination by incorporating a database system to fit the needs of individual programs.

After thorough research and analysis, we were able to develop a set of guidelines that documents various elements necessary for a successful Citizen Science program. These guidelines have been broken down into six chapters for organizations to easily access: successful advertisement techniques to gain volunteer interest, in-depth research on current programs, Citizen Science activities, innovative data collection methods, research on databases used throughout North America, and the Interactive Decision Tree CD. These guidelines provide less developed Citizen Science programs with new ideas for the advancement of their organizations.

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1 Introduction

You are one of approximately six billion humans that make up the earth's population. As an inhabitant of the planet, you contribute to the increasing disruption of our environment simply by performing daily tasks. For example, by driving to school or work, your car is emitting fumes that will add to the already rising pollution levels, and eventually you will have contributed to the formation of ozone near the ground during hot summer afternoons, which is a huge problem for air-breathing organisms. Although the ozone layer destruction is only one of our many environmental concerns, it has made people become very conscious of the environment, and fortunately something can be done to turn our presence on earth into being positive. By the time 2050 arrives the worldwide population is expected to nearly double. A pessimist would see this as a potential threat, as the increase in population could lead to strains on the environment. However, an optimistic would look at this as a great opportunity for us to take what we have and use it for the good of the environment. Given the vast amount of opportunities for volunteering and contributing to the betterment of our environment these days, our world is looking at a brighter future.

Not only could our presence be positive, but our presence in association with other living organisms could also be very positive by making up a healthy biodiversity. A healthy biodiversity provides a number of natural services to society, presenting a possible solution to the negative effects of the rapidly increasing population. A biodiversity consists of the number, variety, and variability of living organisms, commonly made up by the unpredictability of genes, species, and ecosystems. All of these organisms are together contributing to biodiversity. A strong biodiversity provides numerous services to society, including the protection of water resources, soil formation, nutrient storage, pollution absorption, and ecosystem maintenance[3]. These components can eventually lead to the development of food, medical opportunities through pharmaceutical drug research, education, and recreation. The main threat to all species is

[3] Biodiversity and its Value [Internet][cited 2005 March 21] Available at http://www.bio.unipg.it/ecologia/Download/

the loss of habitat, due to the rapidly increasing human population;[4] however, this can be counteracted by the effects of a healthy biodiversity.

We can benefit from the effects of biodiversity by first combining the efforts of the earth's six billion individuals to address and resolve principal environmental concerns and then by utilizing that man-power for data collection. To most people, science is about the search for truth, which is largely associated with the collection of data. Through data collection, we can learn more about climate, pollution, and land surface data, which are all variables that require intense scientific research. Collecting massive data sets such as these can become tedious and strenuous for a single scientist, and even large groups of cooperating scientists suffer from the inability to gather large amounts of quality data. Scientists cannot do this alone, and that is why we must rely on people all over the world to help gather information and record it so that it may be used in the future to help recognize and distinguish changes in our environment.

One of the universal environmental issues that involves immense research and data collection is climate change. The climate itself must be divided into several different subcategories in order to assist scientists and researchers, so that they may gain an understanding in the variations in our weather. There are many components that contribute to the study of climate change, such as air temperature, water temperature, wind, humidity levels, sea level rises, and precipitation[5]. As one can see, all of this information would be impossible for one person to collect, organize, and analyze. The Climate Diagnostics Center, a data collection organization in Boulder, Colorado, has created individual data sets for each type of climate variable that are accessible to the citizens, scientists, and researchers. With the use of surface and high elevation satellites, this has become an ideal system for the scientific community, leading to an improvement in analysis, monitoring, and climate patterns.[6]

Citizen Science is an organized effort for citizens to contribute to their environment and society by collecting data relevant to a specific issue. These issues can range anywhere from the weather, to soil health, to vegetation health. Each program is an

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[4] Global Issues [Internet][cited 2005 March 21] Available at http://www.globalissues.org/EnvIssues/EnvIssues.asp

[5] Climate Data [Internet][Cited 2005] Available at www.science.gmu.edu/~yvikhlya/data/

[6] The Climate Diagnostics Center [Internet][Cited 2005] Available at http://www.cdc.noaa.gov/

independent program from others, causing no two citizen science programs to be the same. One consistency remains however; each program provides a unique outlet for the general public to give back to their environment by volunteering their time and getting involved.

Citizen Science involves concerned citizens from diverse backgrounds who collaborate to monitor, track, and respond to common issues of the community. The main objective in a Citizen Science program is to collect data pertinent to a specific issue. Since this is mostly based on volunteer efforts, scientists are saved from the time and trouble of collecting all of this information themselves. Many programs encourage a lot of public participation, accepting volunteers with no background experience to assist in the data collection process. Over 2,000 citizen monitoring programs have been created in North America[7] alone and major advancements have been made which has impacted citizens' understanding of their surrounding environment. There are three main goals that provide for the success of a Citizen Science Program, which are to make citizens more aware of volunteer opportunities in the areas of environmental science, to easily train volunteers on data collections methods, and to provide scientists with large amounts of quality data that they would not be able to collect otherwise.

For example, one citizen science effort that began in Canada and has since spread to the United States is *Worm Watch*, where citizens take simple measurements of worms within a small area of their yard. Scientists can use this information, in combination with information about the climate and location, to determine soil health[8]. This is a simple program and has been extremely successful in schools because anyone can do it and it provides a great learning tool.

Other organizations have not been quite as successful as *Worm Watch* on the global scale. Though some of these programs have had their own individual success on a local scale, it is difficult to expand beyond anything locally. This is because programs are created individually and are normally not very complementary to each other. Though there are certainly successful Citizen Science programs out there, it appears that many of

[7] Nature Canada [Internet][Cited 2005 February 4] Available at http://www.cnf.ca
[8] Worm Watch [Internet][Cited 2005 March 22] Available at http://www.naturewatch.ca/english/wormwatch

the smaller programs have not modeled their programs off a more successful one, but instead come up with their own ideas and techniques. Though this is not necessarily a problem, it does cause the term "Citizen Science" to refer to a wide variety of programs because there are not very many specifications established about how a citizen science program should be run.

Currently the Museum of Science is interested in working with three organizations in Massachusetts and two national organizations: *the Cape Cod National Seashore, Friends of Fresh Pond, Friends of Menotomy Rocks*, the *Society of Amateur Scientists*, *and The GLOBE Program*, respectively. A representative from the Museum of Science is playing the role of the middleman between these programs and scientists from various colleges throughout the region such as Boston University, Brandeis University, and University of New Hampshire. Their expertise and knowledge of the environment offer an enormous resource to these underdeveloped organizations and a means of communication for scientists to interact with the community.

Society of Amateur Scientists provides membership to people all over the nation who have an interest in Citizen Science programs. One of their objectives is to create contacts among these members, and to eventually create an online profile system where citizen scientists from all over can come together to communicate with one another and share ideas. At *Friends of Fresh Pond*, located in Cambridge, Massachusetts their main focus is to allow the public to study vegetation and animal health at their leisure. This results in people investigating what they are passionate about, and in a small way helping. The data that volunteers provide can be used specifically by the water department, for the sake of bioengineering around the pond, to guarantee the preservation of each ecosystem. The data collection techniques used at this pond will be essential in gaining an understanding of successful methods for gathering and disseminating information through volunteer assistance[9]. The organization has gathered large amounts of data, but faces the challenge of organizing this data in such a way that scientists can utilize it. In their third year they are in the early stages of attempting to publicly market the

[9] Friends of Fresh Pond [Internet][Cited 2005 March 3] Available at http://www.friendsoffreshpond.org/

organization to the surrounding community with the hope of expanding volunteer interest.

Currently many organizations face the challenge of making information about their programs accessible to scientists while organizing it in a simple format; for example, this issue could be addressed by incorporating an appropriate electronic data organizational system. This system could lead to an information database that both citizens and scientists could log into and view the participating parks along with their corresponding information and pictures in an easy to navigate format. At this time, there are few publicly accessible systems in which one can easily access stored and archived data. Without a data dissemination system, volunteers are not able to use the accumulated data themselves nor see the scientific results of the data which they have collected. People like to feel they are doing something that is worthwhile, and with minimal to no motivation for them there is little reason for long-term participation.

1.1 Project Description

The goal of this project was to conduct a comprehensive study of mature Citizen Science Programs in North America in order to develop guidelines and recommendations that will be helpful for less developed and/or newly forming programs.

This involved:

- Identifying various data that are being collected by Citizen Science programs in North America.
- Identifying the research areas that are being carried out by scientists and experts which are benefiting from the data collected by the Citizen Science programs.
- Developing guidelines that document various elements that contribute to the success of a Citizen Science program.
- Researching alternative ways that pictures and video images taken by Citizen Science programs could contribute to the scientists working on environmental issues.

- Identifying various databases currently used by Citizen Science programs throughout North America and distinguishing the characteristics of each system.
- Creating a computer-based decision tree that will allow Citizen Science groups to select a database based on the specifications of their organization.
- Studying various Citizen Science programs and creating a procedure for self-assessment that could be used to evaluate if the necessary components for their success are present.

2 Background

2.1 Citizen Science Programs

Prior to Citizen Science programs, data collection was seriously limited to what information scientists could gather. This resulted in very small amounts of high quality data. Since Citizen Science programs have emerged, there has been a newfound wealth of data.

Citizen Science programs are programs that allow participants to monitor, track, and respond to the developments of public research interests. A program can include the general public, government, and industry volunteers. This design "bridges the gaps that have formed between the sciences and the community, between scientific research and policy, and between decision-making and planning."[10] By utilizing the data collected from previous works, future resources will be able to respond to ecological problems more efficiently.[11]

Citizen Science programs can be applied to a multitude of issues, ranging from scientific unsolved mysteries to cures and advancements in medicine. A large portion of this program includes the monitoring of weather and climate as well as wildlife migrations, reproductive rates and statistics affected by the ever changing world. This information is vital to the efforts of scientists attempting to stabilize our fragile environment.

The many ways in which this data can be collected differs from program to program. One-thing citizen science programs all have in common is the hope to learn and exchange information, to see the changes that have occurred over a period of time and to educate youth about the earth system sciences.[12] Citizen Science programs have opened the doors to successful research developments around the world. The following sections

[10] Coastal CRC [Internet] [Cited March 17 2005] Available at www.coastal.crc.org.au/citizen_science/index.html

[11] Citizen Science [Internet] [Cited March 17 2005] Available at www.kc-citizenscience.net/index.jsp

[12] The Science and the Environment Bulletin. [Internet] [Cited March 20 2005] Available at www.ec.gc.ca/science/sandenov99/article6_e.html

will provide information about some of the local organizations, and some of the more successful national ones.

2.2 Major Worldwide Programs Reviewed

2.2.1 Overview

Citizen Science programs throughout the world have proved to be very advanced with their methods for data collection and organization. Almost all of the programs have developed innovative techniques to gather data that is unique to their field of work. Numerous programs have databases dedicated solely to store and disseminate data for their particular program. These are very valuable to each organization as well as scientists who make use of the collected data. The advanced programs spread throughout the world are a perfect building block for the smaller, less developed organizations.

2.2.2 Cornell Lab of Ornithology

One of the first to experiment with Citizen Science programs was the *Cornell Lab of Ornithology*, located in Ithaca, New York. Since 1987, Cornell Laboratories has been undertaking large scale Citizen Science Projects. With the combination of lab researchers and volunteers, it has become possible to protect and understand birds and their habitats throughout North America. The *Lab of Ornithology* has collected more than 47,000 pieces of information allowing the creation of maps that describe winter bird migrations. These Citizen Science projects have been applied to bird conservation, leading to a purchase of land, where the declining bird species can breed or reproduce. It is for these reasons that the *Cornell Lab of Ornithology* has combined forces and steered other Citizen Science programs to the path of preservation and education.

Cornell Lab of Ornithology is one of the most successful Citizen Science programs in the nation. This has become a non-profit lab between scientists and citizens, consisting of 26,000 members. What makes this organization different from other organizations is the way it has incorporated and stimulated citizens from all ages,

locations, and experiences to create a universal nationwide program that "represents the world's largest research team."[13]

Volunteers begin their efforts by choosing an activity to participate in depending on the specific season of the year. They are then provided with relative links to different programs with detailed instructions on how to identify, count, and record the information that was collected. *Cornell Lab of Ornithology* has made Citizen Science simple, enjoyable, and straightforward, while still utilizing the pieces of information discovered.

Once the data collected is organized, it becomes available to scientists, researchers, and citizens. The researchers' results are published in scientific literature for conservation and study purposes. This helps one get a better understanding of the changes that the birds are experiencing over a large geographical area. Citizen scientists are helping to preserve the extinct bird population by the many contributions each individual citizen makes.

The information is gathered and organized over numerous years in the same location, allowing one to see the changes occurring over a long period of time. Massive amounts of data are also collected to improve bird patterns and predictions. The citizen scientists are asked to record specific findings, including: counts, common species, missing species, and any rare or unusual findings. This narrows the collected data to be information that is needed and required.

Cornell Lab of Ornithology has become a role model and functional program for those who are trying to expand and promote current Citizen Science organizations. It offers links to sponsors, memberships, and news. Also, one can find beneficial bird handbooks and manuals that are posted to help citizens identify and educate themselves on bird biology.[14]

2.2.3 Audubon Science Program

A partner of *Cornell's Lab of Ornithology* is the *Audubon Science Program*. The *Audubon Science Program* is part of three Citizen Science programs: the *Christmas Bird Count* (CBC), the *Great Backyard Bird Count* (GBBC), and *eBird*. The *Christmas Bird Count* is one of the oldest Citizen Science programs that Audubon offers. Due to the fact

[13] Cornell Lab of Ornithology [Internet][Cited 2005 March 29] Available at www.birds.cornell.edu

that more birds are killed over the holidays for meals, citizen scientists began taking bird counts. A program like *eBird*, an online checklist program, also helps contribute and correlate a collection of all the birds seen. This program allows each individual citizen to keep track of his or her own checklist. This also educates communities on how early birds begin migrating and what diseases are impacting birds. The CBC has over 60,000 participants and their work is valued to be about 6 million dollars per year. Over 100,000 citizens are part of the GBBC leading to reports of more than five million birds in addition to 50,000 checklists.[15] These programs are giving birth to a new culture of conservation.

2.2.4 Society of Amateur Scientists

The *Society of Amateur Scientists* (SAS) is an organization founded in 1995 by Shawn Carlson. Today, SAS has over 2,000 participants which include scientists and volunteers. SAS has a newsletter known as *The Citizen Scientists*, which contains information on science tips and a 'how to' guide on becoming a good quality citizen scientist. Citizen scientists willing to assist and work with the organization are offered a discount on the essential materials needed for data collecting. On top of that, citizen scientists are advised and given a helping hand with their individual research projects.[16]

Annual conferences are offered to the members of the *Society of Amateur Scientists*, allowing them to interact and learn about other citizen scientists nationwide. This organization, unlike the *Cornell Lab of Ornithology*, mainly attracts adult citizen scientists for their research projects. Yet, SAS is gradually trying to improve and attract younger members. Online Faculty, a free service, is a collection of science experts who are used to help answer questions that younger members, in high school or middle school, might have on their research topics.

The most recent revolutionary educational project SAS is developing is called LABRats. This program will partner teenagers, grades six through twelve, with science faculty members. These faculty members have been educated in the science, technology, engineering, and mathematic areas. Every week the students get together and work on

[15] Audubon Science [Internet][Cited 2005 March 25] Available at www.audubon.org/bird
[16] Society for Amateur Scientist [Internet][Cited March 2005 March 25] Available at www.sas.org

science activities and go on monthly field trips. The organization is a model created by the parents and volunteers that has been set up so that any uneducated adult or student can follow the activities easily and still sustain interest.

Similar to the girls/boys scout programs, these students earn ranks depending on the comprehension and practice they get from each experiment they do. This cost-free organization is going to pave the road to young successful science and mathematic students. The *Society of Amateur Scientists* has links to workshops, speakers, and conferences relating to citizen scientists.

2.2.5 GLOBE

The GLOBE Program is a worldwide organization that teaches students about science and technology at a level that is not always reached in the classroom. *GLOBE* encourages teachers to assist students by helping to improve their skills in science and math, and in the use of computer and network familiarity. The program enhances learning by increasing student awareness about the natural world that surrounds them daily. It allows students to observe their environment from a scientific viewpoint, rather than overlooking the many educational feats they see while riding their bike or playing outdoors.

GLOBE is supported in the United States by a federal interagency program maintained by NASA, NSF and the U.S. State Department, in conjunction with colleges and universities, state and local school systems, and non-government organizations. On an international level, *GLOBE* carries a partnership between the United States and over 100 other countries. To date, there have been over one million students in more than 15,000 schools who have been a part of the worldwide program, along with 28,000 teachers who have been trained by *GLOBE*.

The basic concepts of the program are to apply the knowledge learned in the classroom and apply it to different methods of testing and data collection. Students experiment by taking scientifically valid measurements on a vast number of subjects such as the atmosphere, hydrology, soils, and land cover within the relative curriculum of the local area. After data collection, they are taught how to report the data by using the *GLOBE* personal Internet database, which collects and stores the data for later

accessibility and use. Once they have successfully stored the datasets, they are trained to create maps and graphs using free interactive programs found on the web. These various types of experimentation through *GLOBE* improve the students understanding of basic science due to their participation in real science through measurements, and analyzing data.

Not only are the *GLOBE* students being educated through their involvement, but they are also assisting in future education through their research contributions, which are used by scientists. This process helps to broaden the possibilities of future scientists and researchers for our schools, industries and government.[17]

2.2.6 Worm Watch

Worm Watch is recognized as one of the more developed and successful Citizen Science programs around the world. "The program promotes awareness of the diversity beneath [the citizens' of Canada] feet through public participation in a nationwide earthworm census."[18] *Worm Watch* has become a Citizen Science program that helps one grasp a better understanding of soil ecology while helping to preserve and sustain the natural environment. The program began due in part to the fact that Canada is such a large country, making it nearly impossible for scientists to gather and examine all the earthworm species necessary for analysis. Therefore, citizens needed to be called upon to engage in some volunteer work that would be both beneficial to scientific efforts and enjoyable.

Worm Watch has developed a set of standard sampling methods that work anywhere and can be applied by citizens and scientists. The methods range from a more informal survey to a method that is both quantitative and qualitative. They have also developed a simple flow chart that a volunteer can use to easily identify the most common earthworms in Canada.

Through the collection and examination of earthworms, various environmental issues can be addressed: soil ecology, climate change, and earthworm history. It is believed that the majority of the earthworms in Canada were killed during the last ice

[17] GLOBE. [Internet] [Cited 2005 March 23] Available at http://www.globe.gov/fsl/welcome.html
[18] Worm Watch [Internet] [Cited 2005 March 29] Available at www.naturewatch.ca/english/wormwatch

age, and then reintroduced when the Europeans settled in North America. Scientists are skeptical that this is the case because earthworms move very slowly over time, yet are very widespread throughout the country. Through the data gathered by *Worm Watch*, scientists can determine the actual history of the earthworms in Canada, providing a broader outlook on environmental concerns, such as climate change and soil ecology.

2.3 Local Programs Under Review

2.3.1 Overview

As we have seen, there are many Citizen Science programs that have been very successful throughout North America. These programs have realized their success through many accomplishments: understanding the best ways to motivate citizens to become volunteers in their organizations, offering both entertaining and educational projects, and organizing a collection of the data and information they have compiled over time. Our goal is to assist the local Citizen Science programs in achieving this level of success. The three organizations that we will most be focused on are: *Friends of Fresh pond, Friends of Menotomy Rocks,* and *Cape Cod National Seashore.* Background information on each program and their methods will be necessary for us to make significant contributions to their efforts.

2.3.2 Friends of Fresh Pond

Currently, one of the organizations the Museum of Science liaison is interested to work with is the *Friends of Fresh Pond*, located in Cambridge, Massachusetts. The *Friends of Fresh Pond* is a volunteer group offered "to citizens whose purpose is to enhance and protect the natural environment of Fresh Pond through education and community participation. [They] seek to create a community of educated people who have a sense of stewardship for the Reservation."[19] For the past three years, they have offered numerous activity-based programs designed to develop observation skills while building a community at the Reservation.

[19] Friends of Fresh Pond [Internet] [Cited 2005 March 23] Available at http://www.friendsoffreshpond.org/

The organization has done extensive work to reach out to the citizens in and surrounding Cambridge in order to build a greater appreciation and community for Fresh Pond. The staff is constantly posting flyers on the Reservation and in the local schools and libraries to attract more volunteers. They have also set up an alias that contains over 400 names of people who regularly receive emails about the upcoming events. In addition, they send notices and newsletters to the *Cambridge Chronicle* and *Boston Globe* in order to publish their volunteer projects. The Reservation also holds biannual dinners for their members to receive feedback and ideas.

Figure 2: Map of Fresh Pond Reservation

Since its foundation in January of 2002, the *Friends of Fresh Pond* program has acquired approximately 155 members through individual and family memberships. These memberships allow one to become a part of their various activities, which include, but are not limited to: guided walks featuring birds, insects, trees, and wildflowers; volunteer workdays with reservation staff; participation in biodiversity surveys; outings with students; and member-suggested events. Regular memberships are $10, $5 for seniors and students, and family memberships are offered for $15. The money collected is used towards the reproduction of educational materials, purchases of field guidelines for members' use, maintenance of their website, and purchases of materials for animal habitat improvement and other projects.

When collecting data, the staff and volunteers focus on making inventories of trees, wildflowers, birds and theirs nests. They apply numerous methods of data collection and tracking processes, and have future plans to implement new techniques that will provide assistance in learning more about the Pond. After collecting the information, the group organizes the data and creates a list that is made accessible to the

public. Through these techniques, the program collects data and images, with the hope of beginning to observe patterns, changes, and relationships among the species and environment over the next several years.

Figure 3: Aerial view of Fresh Pond

One example of data collection that the *Friends of Fresh Pond* organization has utilized is the tracking and monitoring of different species of birds at the Pond. On any given day, staff and members of the program walk through the reservation with a checklist of numerous residential and migratory bird species. The onlooker makes observations such as the location of the spotting, the time of day, what type of species it is, and how many birds of that species are present. These observations are then compiled into a list and made public on the Internet. For instance, on March 20, 2005 alone, nearly two hundred fifty birds of twenty-nine various species were witnessed by three separate volunteers. Although it may not seem significant, data such as this can educate us as to what types of birds are migrating towards our region, and approximately what time of the year it occurs. This is only one example of data collection that is both valuable to the organization and easy to gather by its staff and volunteers.

2.3.3 Friends of Menotomy Rocks

Menotomy Rocks Park is a public park located in Arlington, Massachusetts that is composed of over thirty-five acres of woodland, walking paths, play fields, and a three-acre pond. The *Friends of Menotomy Rocks* organization was established in 1993 "to advise the Town of Arlington concerning the use, care, and maintenance of the park, to assist in the preservation and improvement of the land, to help keep and improve the fields, pond, plantings, pathways, trees, and other natural features of the park, to improve

species' habitats, and to assist in the maintenance and provision of facilities furthering recreation and enjoyment of the park."[20] In addition, the program organizes educational programs for the public to disseminate the values and ideas upon which the local park relies.

The organization consists of thirteen people of various age groups who care about the recreational and artistic aspects of the park. The groups is especially focused on making the park more inviting to those who are concerned with their surroundings and would like to take positive action to improve the environment. *Friends of Menotomy Rocks* primarily uses Earth Day and Biodiversity Day as its advertisement tools where younger participants take part in Earth appreciation activities. The members fund the organization, and all of the money is spent towards the infrastructure of the program.

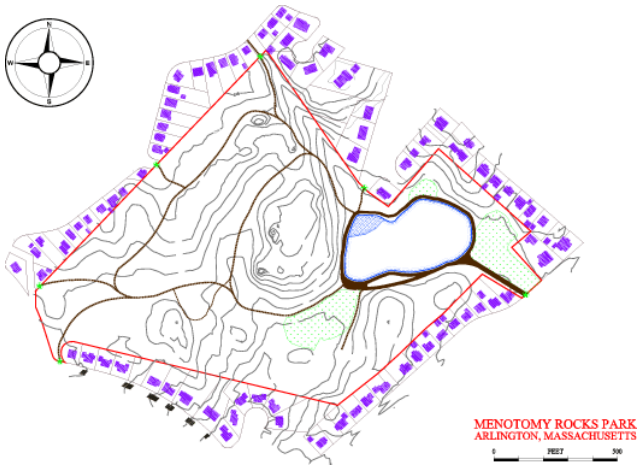

Figure 4: Map of Menotomy Rocks Park

The main focal point of data collection for this organization is to observe how the pond and its residents affect one another. Through the testing of water quality and examination of digital photography, countless observations can be made about the ecosystem. By studying picture post photos and time-lapse films, participants are able to monitor how the lives of plants and animals are changing over time and how land cover use effects the environment. Since these films allow people to visibly observe natural alterations over time, factors such as climate change, air quality, and which invasive species eventually affect the surrounding vegetation can be determined. They are also effective in viewing the phenology of plants and animals (reactions to natural phenomena over time), such as the greening up of a tree in the spring. Through these images and the collected water quality data, one can see how invasive pondweed, old or dying plants, and pollution negatively affect the pond.

[20] Friends of Menotomy Rocks [Internet] [Cited 2005 March 24] Available at http://www.friendsofmenotomy.org/

The *Friends of Menotomy Rocks* organization faces two main challenges: providing a web organization system and the training of its volunteers. The group would like to locate someone who would have the ability to consistently update and organize an informational database of the collected data at the park. Ideally, the program would like to train their staff and volunteers twice a month on the use and advantages of digital photography. However, this type of training would take a lot of time and would require a large group of volunteers, both of which they are lacking right now.

2.3.4 Cape Cod National Seashore

The Cape Cod National Seashore consists of 43,604 acres of land with many distinct aspects that make the land unique. It has a multitude of organisms and ecosystems that are almost entirely rare to this area of the world, which makes it even more fascinating that it is all located on one seashore.[21] The development of this land has ultimately contributed to causing setbacks in its natural development. Scientists are currently looking into a way of restoring Herring River Marsh in Wellfleet, Massachusetts, which at one point was a saltwater marsh. Due to land developments, tidal waves could not reach this marsh as easily as before and thus the water supply gradually was cut off. This resulted in the slow changeover to more of a freshwater marsh than a saltwater one. The many unique organisms that habituate in saltwater marshes can only survive in saltwater marshes, and saltwater marshes alone. This change had a huge effect on these organisms and many fish were killed over the 1100-acre saltwater marsh. Scientists are now trying to come up with

Figure 5: Aerial view of Cape Cod National Seashore

[21] Cape Cod National Seashore. [Internet] [Cited 2005 February 9] Available at http://www.nps.gov/caco/

a way to restore this marsh back to its original state by opening up the tidal flow once again and allowing the saltwater to reach the marsh.

2.4 Technology and Citizen Science

Today, technology, particularly the Internet, is helping Citizen Scientists from all over the world to network their ideas and observations with one another. The Internet has allowed citizens to receive information from various geographic locations and is shaping the future of Citizen Science programs. Everyday a Citizen Scientist reports their findings for that one day, with the intentions of helping other scientific communities around the world find the answers to their questions. "The Internet has changed everything, even desperation[22]."

Without this new research method, many scientific questions from the past would have never been answered. The efforts and contributions of the hundreds and thousands of volunteers have brought the scientific community to new and improved levels of thought, sequence, and organization. As time passes and technology advances and progresses, so do the new ways of preserving and protecting what we have already achieved. Through these advancements, our society has been given the opportunity to explore new information while sharing it with the community.

2.4.1 Databases

A database consists of a set or sets of associated data. Databases are everywhere; in the doctor's office, in the police station, even at the grocery store. Any time information is being stored, chances are it is being stored in a database. There are two different kinds of databases, flat-file and relational. Flat-file databases are very simple and do not rely on a lot of linked files. Relational databases are more complex, and can be utilized for much more data storage than flat-file databases. They also allow one to create relationships between different fields, which helps for linking items and minimizing data redundancy. The relationships established through the database make

[22] Solovitch, Sara. "The Citizen Scientists," Wired, Feb 2005, 5.

querying possible, which means that data can be sorted and pulled up in various different formats, whatever is most convenient.

Two of the most popular database software used today are Microsoft Access and Oracle. Access is convenient and widely used by many, for the sheer convenience of it being linked as part of Microsoft Office. It is much more easily obtained, and far less expensive. Oracle is much more sophisticated than Access, but the software is much more expensive and is not used as commonly by individuals and small organizations. MS SQL Server is considered to be the big brother of Access and a competitor to Oracle, but Oracle remains to be the more popular of the two.

The future of databases seems to be heading towards open source databases that are run off of servers. The technology is out there, and as organizations start to become more and more internet based, there will be a migration in the open source direction. Why pay for something that can be found online, is just as good, and is free. In this situation, the issue is really about where the server is located and who maintains the server, because everything else will be done through a web interface accessible from anywhere with an internet link.

This project examined various databases used by different citizen science programs to understand what was beneficial and what was not, and to provide recommendations to other programs.

3 Methodology

As was previously discussed, the ultimate goal of this project was to assess the opportunities and challenges for the advancement of Citizen Science programs.

To accomplish our mission, we identified seven primary objectives for our project:

1.) Identifying and classifying various data that are being collected by Citizen Science programs in North America.
2.) Identifying the research areas that are being carried out by scientists and experts which are benefiting from the data collected by the Citizen Science programs.
3.) Researching alternative ways that pictures and video images taken by Citizen Science programs could contribute to the scientists working on environmental issues.
4.) Identifying various databases currently used by Citizen Science programs throughout North America and distinguishing the characteristics of each system.
5.) Creating a computer-based decision tree that will allow Citizen Science groups to select a database based on the specifications of their organization.
6.) Studying various Citizen Science programs and creating a procedure for self-assessment that could be used to evaluate if the necessary components for their success are present.
7.) Developing guidelines that document various elements that contribute to the success of a Citizen Science program.

The chapter is divided into the following sections:

- **Section 3.1** discusses the interview process that were done to identify the vast range of data collection methods throughout North America and the classification approach that was be used to make the results easily identifiable.
- **Section 3.2** explains the interview procedure that was used to identify the various research areas that Citizen Science programs study to determine its assistance to scientists and experts.
- **Section 3.3** gives details on the approaches to determine successful alternative methods for digital imagery data collection.
- **Section 3.4** discusses the interview process that was carried out to examine various databases used by Citizen Science programs throughout North America.
- **Section 3.5** provides details for the creation of an original interactive decision tree to offer assistance to interested programs.
- **Section 3.6** explains how the team assessed various organizations to create a structure which produces self-recommendations that can be used to evaluate the current mechanisms of any program.
- **Section 3.7** discusses the steps that were taken to create guidelines that provide information on the elements that have contributed to the successes of developed programs.

3.1 Data Collection in North America

The key to understanding the various types of data being collected is to research and explore the Citizen Science programs in North America. By conducting interviews, these programs were evaluated based on the type of data they collect, and the types of methods used for gathering data. Once the group identified the data that were being collected by each organization, it was classified into a major sub-grouping based on its relation to the environment. Each program can be characterized into a major classification; for example, *Worm Watch* can be categorized into the "invertebrate animals" class with a subsidiary grouping of "worms". Each grouping contains

information about the range of data that are being collected by that particular organization.

3.1.1 Interviewing Representatives of Current Programs

To understand the mechanisms of Citizen Science programs, we first began by exploring the specific types of data that are being collected. Ongoing programs are the key to understanding the main instruments that different types of programs use for data collection. We started the process by interviewing as many programs as possible by using an Excel formatted interview (See Appendix A). The information from each of the interviews provided a core understanding of the various data that are being collected over the North American continent. Next, we researched programs that have already displayed specific areas of achievement and located the essential tactics which led to their success. The information received was shared with local programs to further educate them on successful current Citizen Science efforts; our hope was for the programs in the area to benefit by gaining new understandings of worldwide volunteer participation and data collection methods.

3.2 Interviewing Scientists

Scientists within the Boston area, particularly at Boston University were a great assistance in understanding how the data collected by Citizen Science efforts is utilized. Through their assistance, we discovered the link between science and citizens, along with the uses behind the data that are being gathered. To determine what specific data are being used, we first conducted an interview with the scientists to gain an understanding about the types of data they receive. During the interview, we focused on the different ways the scientists obtain the data collected by organizations. Once we grasped how the information is passed to the scientists, we asked questions about the precise uses for it (See Appendix B). As, we anticipated the interview process opened new windows towards the connection between the citizen and science components.

3.3 Innovative Data Collection Methods

By experimenting with various types of advanced data collection methods, the group proposed the most effective and economical techniques for the advancement of Citizen Science programs. By testing individual devices, recording the results and analyzing the information found, we assessed the strengths and weaknesses of each collection method. The most cost-effective yet efficient ways were documented and recommended for use to local organizations hoping to advance their programs.

3.4 Researching Various Database Systems

To understand the numerous database systems used throughout North America, the group created an interview for various Citizen Science programs to learn about the software they currently use (See Appendix C). This information provided a useful basis to conduct research on the different systems that are utilized by Citizen Science programs. After the interview process was complete, the team expanded the information on each database by researching each of them individually. The important components of each database such as, cost, user-friendliness, maintainability and system requirements were then ranked based upon the results from the interview and individual research. The ranking was scaled by the numbers one through three- a number one would indicate the best possible ranking, a number two designated a decent ranking, and a number three was the worst possible ranking, specifying it as poor.

3.5 Creating an Interactive Decision Tree

By creating an interactive decision tree to create recommendations through querying results, organizations will benefit from interview results researched in depth. The information within the decision tree was obtained from the interviews with various organizations and contains results such as the type of database used, data storage system and cost. The end result is an interactive piece that produces individual recommendations based on the needs of the program.

3.6 Citizen Science Self-Evaluation Process

To offer effective recommendations for programs both locally and worldwide, the group began by determining the essential traits that influence the success of a newly forming organization. To commence, we made use of the information gained from the various interviews conducted to learn about the initial establishment of Citizen Science organizations. By compiling the useful knowledge, a questionnaire was created to realistically evaluate if the necessary mechanisms of any Citizen Science program are in place. The assessment is based on the aspects considered to be essential for the foundation of a recently developing program such as, marketing, advertisement and support.

3.7 Developing Guidelines for Citizen Science Success

After carrying out our initial objectives, instructional guidelines were created that contain educational information on the process of starting, expanding and maintaining a Citizen Science program. By combining the interviews of current Citizen Science programs in North America and scientists using data from organizations, guidelines were created using the analysis of these results. These guidelines offer information on the elements that have aided current programs to their success. They include: a self-evaluation for programs to assess themselves with; marketing and advertisement techniques; an index of current Citizen Science programs along with the data they collect, what the data is used for, and activities they use; new and innovative data collection techniques; an interactive decision tree; and numerous database descriptions. This can be of great assistance to underdeveloped programs, as it will present insight on methods to advance their programs.

4 Results and Analysis

4.1 Citizen Science Programs in North America

4.1.1 Overview

Citizen Science programs throughout North America play an essential role in understanding the types of information scientists and researchers study. Through initial research, the group extensively studied twelve local and worldwide programs to learn about the types of data collected and how it is used. Some organizations proved to be significantly harder to gain particular insight about due to the lack of information on the Internet. To further comprehend the applications of Citizen Science programs that do not offer much information on their web sites, the following organizations were interviewed to learn more about the specifics of their programs. Citizen Science programs that offered a large information base online were also interviewed in depth to discover the exact mechanisms of their organization.

4.1.2 Vertebrate Animals

4.1.2.1 Birds

4.1.2.1.1 Cornell Lab of Ornithology - Feederwatch

Cornell Lab of Ornithology is a non-profit organization that aims to understand and conserve the earth's biological varieties through research, education, and Citizen Science programs. Feederwatch, one of Cornell Lab of Ornithology's Citizen Science programs initiated by the community's interest in birds was developed in 1987. Currently, there are approximately 25-30 members working with Feederwatch ranging from all ages, but the majority being senior citizens. Every year, Feederwatch members contribute a fifteen-dollar annual membership fee. With the help of the National Science Foundation, along with private foundations, *Cornell Lab of Ornithology's Feederwatch* is able to fund enough money to pay staff members while creating and sending instruction manuals on data collection.

Cornell Lab of Ornithology's Feederwatch specifically collects data on birds, weather, habitat information, amphibian monitoring, and butterflies. These data collections are done to see the habitual changes over time. An eight-page instruction booklet is sent to members' homes once the fee is paid in full. Binoculars, birdfeeders, and bird boxes are all things that can be used when collecting data, but are not free of charge. Recruitment has become one of the biggest challenges that *Cornell Lab of Ornithology's Feederwatch* has come across. Although, birds have become a natural hook for members, the marketing communications office is still looking for ways to recruit members through local newspapers and newsletters.[23] (See Appendix D)

4.1.2.2 Various Wildlife

4.1.2.2.1 Adirondack Cooperative Loon Program

Adirondack Cooperative Loon Program, a Citizen Science program in Ray Brook, New York has been working with environmental data since 2001. The *ACLP* is a combination of researchers and educators working to study the natural history of the common loon and the effects of contamination and human interactions on the Loon population in the Adirondack Park. With the help of two working staff members and several adult volunteers, they have been able to determine the impact of environmental mercury pollution on wildlife population and habitat utilization. The volunteers are trained individually and are recommended to attend a public presentation to understand the organization's objectives. Excel spreadsheets are posted on the *ACLP* website, then incorporated into an access database, and results are again posted on the website where citizens and researchers can access the information.

One challenge facing the *ACLP* is not having enough time or staff to respond to all of the information requests from the public in a timely fashion. Another major need of the *ACLP* is the funding for staff salaries in order to help coordinate the program's research and education efforts, prepare and distribute outreach materials, and obtaining office and field expenses. *ACLP* does receive grants and donations from the Wildlife Conservation Society and the Natural History Museum of the Adirondacks. With the help

[23] David Bonter, interview by author, Boston, Massachusetts, 6 April 2005.

of their website and biannual newsletters, the program is attracting more and more volunteers each year.[24] (See Appendix E)

4.1.3 Invertebrate Animals

4.1.3.1 Worms

4.1.3.1.1 Worm Watch

The *Nature Watch* program was the original foundation for *Worm Watch*, which began in 2000. *Nature Watch* is a program that was initially started by the government to track various data to learn more about aspects of nature. As volunteers began to collect, they realized that nature expanded far too broadly to be tracked by an individual program, leading to the start of *Worm Watch, Plant Watch, Ice Watch and Frog Watch*. The combinations of these four programs accumulate to produce over 25,000 volunteers across Canada, along with supervisors at each major site. By simply becoming a member of the *Nature Watch* community, each program offers a regional and local center that is open for the use of the public communities. The process to become a member takes less than one minute and allows the user to access any information stored within the database.

The *Worm Watch* program is federally funded and has the ability to get financial support from organizations throughout Canada. *Worm Watch* uses earthworms get a better understanding of soil ecology in helping sustain agriculture and the natural environment. A network of universities, scientists and interested individuals research the information gathered by *Worm Watch*. Ultimately, they use the information to produce assessments of what is seen over the years. The information is documented into the *Nature Watch* database, and is stored for distribution purposes and future use.

Worm Watch has become a foundation for adventurous students over the past five years, expanding immensely into levels from kindergarten through twelfth grade. The program has been implemented into hundreds of schools where the data is collected regularly in classroom efforts. Each student is responsible for a particular plot of land where they can track information on the soil and the existence of worms within their area. Once the data is collected, the classes can collaboratively or individually enter the

[24] Nina Schoch, interview by author, Boston, Massachusetts, 8 April 2005.

information into the *Nature Watch* database through a simple template. It is then available for viewing by the classroom as well as any member of the *Nature Watch* program. The universities and scientists benefit immensely from the assistance of volunteers from *Worm Watch*. The large amounts of data recorded are eventually applied to learn more about climate change and migration patterns.

Wormwatch recruits volunteers using flyers and marketing techniques. Although one problem Wormwatch has experienced is difficulties with online and mapping systems. Yet for those underdeveloped programs, Wormwatch suggest that you get the attention of volunteers who don't have to spend money to join but can easily help.[25] (See Appendix F)

4.1.3.2 Insects

4.1.3.2.1 New England Household Pests

Gary D. Alpert, an entomologist, with help from Harvard University, is the founder of *New England Household Pests*, a program which started three years ago in means to answer questions on all different types of home-invading bugs. Insects in New England are an important part of the environment; *NEHP* has created a way to control them using a non-chemical pest strategy. Gary D. Alpert is one of four PhD level volunteers that work with the *NEHP*. The Environmental Protection Agency has helped fund the organization with their $30,000 lump sum level of funding required for the functioning of the program.

Equipment used for data collection consists of digital cameras and microscopes, which are both provided through the funding, gained. In the future they hope to have better images and upgrades in the software, along with creating a more colorful, fun and user friendliness interface for users. Identifying any insect that they may come across in the United States is also going to be among there goals. *NEHP* recommends that underdeveloped programs plan a network of people and volunteers prior to starting the program. There is good science behind the images and the *NEHP* organization and they would like to eventually expand throughout the United States.[26] (See Appendix G)

[25] Elizabeth Kilvert, interview by author, Boston, Massachusetts, 5 April 2005.
[26] Gary Alpert, interview by author, Boston, Massachusetts, 7 April 2005.

4.1.4 National Parks

4.1.4.1 Friends of Acadia

Friends of Acadia, an organization focused on the Acadia National Park, was established in 1986 with the intent to protect the natural beauty, ecological vitality, and the cultural distinctiveness in the surrounding area. Last year alone, the organization had 2,200 volunteers and they currently have five to six interns, nine full-time staff, and two seasonal volunteers. Through private funding, contributions, and grants, *Friends of Acadia* has been able to acquire equipment and paid staff. A large majority of the volunteers consist of high school students, college students, and senior citizens.

The plants, trees and flowers surrounding the park are digitally photographed and stored, yet there is no current use for them. With a clipboard and pen, ridge runners, or volunteers, collect information on hiker censuses and random samples of the number of people on trails. Volunteers also do carriage work, roadwork, and maintenance. Ridge runners are informed by word of mouth, brochures (at hotels and inns), in the park, and newspapers and should be trained to use first aid kits and be CPR certified. [27] (See Appendix H)

4.1.4 Plants

4.1.4.2 Journey North

Journey North is an organization, founded by Elizabeth Howard that happened to branch off of an arctic migration sub-project in 1991. This Citizen Science program aimed to help aid and demonstrate to students and teachers on comparative analysis on the changes in the habitat and environmental conditions. Currently, there are 10-12 paid staff members that work on a team for *Journey North*, along with 20 researchers that are directly involved on a regular basis.

The data collected consists of when different species of plants first emerge in each season, along with other various types of phenology data. Once the data is collected, volunteers are pre- registered online and are requested to fill out field forms which eventually go to a central database. Then the data is used in the classroom to help create a

[27] Stephanie Clement, interview by author, Boston, Massachusetts, 7 April 2005.

visual sense of what goes on in the environment. Funding required for the program to function is $400,000 per year and the Annenberg Foundation, one of the largest foundations in the world, helps support the program.

Asking teachers to change their style of instruction so that they can take full advantage of the program is a challenge that *Journey North* faces. Also, the perception that it is an elementary project is something that the organization wants to change. In the future, they plan to develop television and film programs that will draw different audiences to their organization. Joel Halvorson suggests that underdeveloped programs try not to do everything at once instead start small and avoid collecting data for nothing.[28] (See Appendix I)

4.1.4.3 Friends of Fresh Pond

Friends of Fresh Pond is a group of volunteer citizens whose intention is to enhance and protect the natural environment through education and Citizen Science participation. Citizen Science efforts occur in Cambridge, MA at the Fresh Pond reservation. The group consists of 122 members, who have joined for various reasons; some join to help the community, others to conserve the park, and the rest due to their love for nature. Although, a recent study proved approximately forty percent of the people that travel through the reservation live out of town, and about ten percent of the locals who travel through have an interest for nature. This, posts a problem for the park to attract a willingly helpful community, as it is very important that the park maintains a clean and friendly atmosphere for the members in the surrounding community.

Friends of Fresh Pond keeps a well-organized inventory of natural resources, water samples, trees, plants, and ground water well samples. These inventories are offered in paper form along with an online database list. Photographs have become very important to the program; therefore, a system where they can format, hold, and store thousands of pictures has become a great need. Other challenges that the organization faces is the ability to collect accurate data and transition it into useful information.

Members of *Friends of Fresh Pond* can go through an optional training process before entering the data collection process. Members can be trained in wildflower

[28] Joel Halvorson, interview by author, Boston, Massachusetts, 7 April 2005.

identity, tree identity, and bird watching techniques. The training program is a free two-hour class that gives members access to field guides and binoculars. The organization advertises each month by posting orange and green flyers, press releases, websites, and via emails.

The park is currently entering a construction stage, therefore information on water treatment and environmental changes will become vital to the park's ecosystem. *Friends of Fresh Pond* hopes to change the way people think, act, or feel about the environment in order to help preserve and maintain the park at its healthiest setting.[29] (See Appendix J)

4.1.5 Water

4.1.5.1 Friends of Menotomy Rocks

Friends of Menotomy Rock started approximately twelve years ago because the community cared about the park recreationally and wanted to make it inviting for other citizens. *FMR* are concerned with the care, use, and maintenance of the park. They would also like to improve and preserve the natural features of the park. *FMR* has been difficult to maintain due to destructive teenagers that come into the park during closing hours and vandalize it with broken bottles and trash. With the help of Earth Day and Biodiversity Day, similar groups have been able to recruit enough volunteers to assist in making the park an enjoyable place for all members of the community.

FMR has 13 members from all different age groups that conduct water tests, record phenology data, observe green up and green down, bud bursts, migrations, and take part in bird walks. The water poly testing kits are about $1500 and can help determine how invasive pondweed, dying plants, and pollution can affect the pond. The program has also used time-lapse and digital photography to determine climate change, air quality, and invasive species that eventually affect trees. These changes can also help volunteers see how the animals' lives are changing and how land cover use affects the environment. *FMR* would like to create a web organized system to store video clips and pictures and training possibilities have been considered for these activities, but with the lack of time and funding, they have not been able to do so.[30] (See Appendix K)

[29] Jean Rogers, interview by author, Boston, Massachusetts, 30 March 2005.
[30] John Pickle, interview by author, Boston, Massachusetts, 30 March 2005.

4.1.5.2 Mount Desert Island Water Coalition

MDI Water Coalition is a non-profit organization located in Mount Desert, Maine, supported by the island residences. Through environmental research and education the MDI Water Coalition helps preserve and improve the water quality at MDI. A high school teacher, Jane Disney, with the help of the Maine Shore Stewards, founded the MDI Water Coalition in 1993. The MDI Water Coalition was initiated in hopes to engage people in preserving and improving water quality. MDI Water Coalition is also a partner with Partners in Monitoring Grant and with the Frenchmen Bay Conservancy, and MDI High School. Currently they have dozens of adults and 400 students per year, ages ranging from 8 to 80. At the time they have one researcher that collects data and works with the program.

Phytoplankton, water quality, beach user information, and pollution sources is some of the data collected by the MDI Water Coalition. The data collected is for helping preserve local environments and to protect public health. Teachers and members go through a training process for several hours. The data collected is put into field sheets and lab logs, and then organized into hanging folder systems. From the data collected MDI Water Coalition can learn where the water quality is being impacted and affected. Members may use a research lab at the MDI Bio Lab to work with data collected. Also, members are asked to follow procedures from the Quality Control Project Plan, which maps out protocol. The beach data collected is used for local beach safety and the Phytoplankton, is used by the state to look at red tide potential. Future data collection methods that have been considered are: monitoring around cruise ships along with developing a way to have open ocean protocols for sample collecting.

MDI Water Coalition recruits members through there website, press releases, word of mouth, and posters. One of the biggest challenges has become funding, although they do get funding through grants, membership dues, and by soliciting businesses for projects. In the future MDI Water Coalition hopes to become part of a larger non-profit organization that will be housed at a local college or at the MDI Biological Laboratory. In

order to secure the future of the MDI Water Coalition they will have to consider an endowment.[31] (Appendix L)

4.1.6 History and Technology

4.1.6.1 MIT's Collaborative Mapping Initiatives

For the past two years the Massachusetts Institute of Technology has been exploring wireless GPS and GIS systems in order to discover ways in turning the surrounding Boston and Cambridge areas into historical museums. This meaning that if you see a building on campus and would like to know its historical background you can use a GPS or GIS system to look up the building you are looking at and find historical information on it from the past 500 years. This can range from songs, pictures, and audio clips.

MIT's Collaborative Mapping Initiatives is a Citizen Science program based on the National Heritage Database inspired by Eric Heller, a Harvard University graduate. In essence, the volunteers are attempting to map out historical locations around the MIT campus, and then link them to a GIS program that will display information about the site. Currently, MIT is looking to identify meaningful historical sites in the Cambridge and Boston area.

In preparation to fund this project, there has been a formal meeting in order to establish the correct budget for the proposals. Presently, *MIT's Collaborative Mapping Initiatives* is conducting workshops on history and technology to help recruit members who have an expertise in a particular fields in the humanities and social sciences. By 2008 *MIT's Collaborative Mapping Initiatives* hopes to create a proposal for a future pilot system that will eventually become the basis for a larger system. [32] (See Appendix M)

4.1.6.2 Cape Cod National Seashore

Staff and volunteers at the *Cape Cod National Seashore* (CCNS) are working together to organize and run Citizen Science efforts in hopes of collecting scientific data

[31] Jane Disney, interview by author, Boston, Massachusetts, 26 April 2005
[32] Debbie Douglas, interview by author, Boston, Massachusetts, 7 April 2005.

that, over time, will assist in identifying and measuring changes in the dune and salt marsh ecosystems. The organization is a Citizen Science program that collects research data depending on the needs of scientists, researchers, and national parks. The data collected consists of shoreline change, onshore change, bars, angles, and waves. Once this data has been collected it is then handed down to the National Park Service, where they can view the changes occurring within the park. Pictures have been consistently collected for over a year and a half and the program is attempting to continue the collection by educating students and teachers on photographs. Each picture is labeled with properties according to change, size, and distance, which provides great assistance when working to conclude results.

CCNS primarily focuses on aerial photos that are taken by volunteer pilots from the Fitchburg Pilot Association. Only the researchers and staff members, regarding insurance purposes, do the aerial pictures. When in flight, the pilots record data such as: change in altitude, landmarks, angle of sun, wind conditions, and change in speed. This data is analyzed by scientists and becomes valuable information on coastal change, animal behavior, impact of trails, and plant phenology. The organization uses this information to help recreate the picture or image at the National Park. Members store all of the obtained information on a hard drive and post it on a government server where all national park information is stored, for the public to access.[33] (See Appendix N)

CCNS is also working on collecting bivalve species richness along with the density in the East Harbor. Collecting data on bivalve density richness will provide information on bivalve populations and enable researchers with enough information to detect changes in the East Harbor. Considering that bivalves have just recently returned to that estuary, it will become important to the parks restorations. Participants receive a half-day training period by a visiting researcher. Once participants are trained they then go out in small groups then will locate sampling points, set up quadrants, and take benthic cores at the bottom of the sea. Then each quadrant is raked with a clam rake and then the benthic cores are put through sieves, which sieve out and identify the bivalves. Some of the costly equipment used for these projects consists of clam rakes, soil sieves

[33] Barbara Duggan, interview by author, Boston, Massachusetts, 23 March 2005.

GPS units; PVC quadrants, soil corers, field guides and chest waders, yet these items are not free.

This project will provide information on bivalve species richness and density at East Harbor. If this project is repeated for the next 3-5 years it will provide information on the population of bivalves and the East Harbor changes over time. Presently, *CCNS* is trying to recruit members from local organizations that already have a volunteer basis for instance Senior Environmental Corps and Friends of Cape Cod National Seashore. *CCNS* also plans on posting flyers in local libraries and visiting centers to attract the attention of volunteers.[34] (See Appendix O)

4.2 Scientists Researching Citizen Science Data

A general interview was created specifically to gain insight about the different ways scientists acquire knowledge from data collected by Citizen Science efforts. The group contacted various scientists within the Boston area; an interview was conducted with Dr. John Hodges, a Boston University scientist who works in the Department of Geography at the Center for Remote Sensing. Dr. Hodges is only a small part of a large international team of engineers and scientists working to provide a better understanding for our world.

Boston University is exploring the potential of collaborating with Citizen Science programs to gain new ways to acquire mass amounts of data. They are presently evaluating the various data available through GLOBE, a worldwide K-12 Citizen Science effort. This could provide a great assistance to the scientists as they could be consistently presented with data that could not be collected by a single person within a specific area. The idea of incorporating Citizen Science to the efforts of the University would open new doors within many centers and laboratories.

Boston University is a part of an international effort to effectively quantify numerous global issues. They focus particularly on land cover classification and land cover phonology, which both are essential for global systems science. The data currently

[34] Amy Brett Thelan, interview by author, Boston, Massachusetts, 26 April 2005

being observed is rooted from observations of NASA's EOS MODIS satellite. The majority of the information collected is used to study digital raster formats, although many historical maps are often compared to new information because it offers a new insight to the world.

The data collected and reviewed by Boston University is archived by the United States Geological Survey and are available at http://edcimswww.cr.usgs.gov/pub/imswelcome/. The data is used by scientists who are attempting to gain an understanding of global climate, aid agencies trying to allocate resources, regionally public policy planners, and conservation advocates. The final conclusions made are put into reports that are published journals such as, Science, Nature, the Journal of Geophysical Research, Remote Sensing of Environment and the International Journal of Remote Sensing.

John Hodges team of scientists and engineers are part of a worldwide effort to learn more about our plant. With the assistance of Citizen Science, the team realizes the opportunities that can be established by gaining new mass amounts of data. Hodges feels the perfect link to integrating with Citizen Science organizations is the Boston Museum of Science.[35] (See Appendix N)

4.3 Innovative Data Collection and Analysis Methods

4.3.1 Overview

Through interviewing the representatives of Citizen Science programs, we have discovered various data collection methods applied by different organizations. Many programs, such as *Friends of Fresh Pond*, form observations by simply counting and recording different species of plants and animals. The *Friends of Menotomy Rocks* group has volunteers test the pH levels and water quality of the pond in their park with their own testing kits. And still others, like *Cape Cod National Seashore*, have volunteer pilots take aerial photos of their reservation from airplanes. However, through discussion with

[35] John Hodges, interview by author, Boston, Massachusetts, 26 April 2005.

our sponsor, we have realized new methods of data collection that will be valuable to Citizen Science programs. Napoleon Bonaparte once said, "A picture is worth a thousand words;" similarly, we believe that photographical data collection can be far more educating and exciting than traditional methods of gathering data. In the following sections, we will be discussing the idiosyncrasies and advantages of picture post photography, time-lapse films, filtered lenses, and tracking programs, along with any issues we might see as being a drawback.

4.3.2 Picture Post Photography

One form of advanced data collection that we believe will be an integral part of the progression of Citizen Science programs is the picture post method. This concept was first brought to our attention by our sponsor, John Pickle, in cooperation with representatives from the *Friends of Fresh Pond* organization. This particular method will ultimately provide both citizens and scientists with a 360˚ panoramic view of their environment. Like a puzzle, gathering images of different angles of a specific area and piecing them together will provide organizations with an enhanced view of the "bigger picture" of their surroundings. This "puzzle" could provide scientists with the necessary photography to study and analyze how certain areas of our environment are changing over time, without being concerned about inconsistent and irrelevant data.

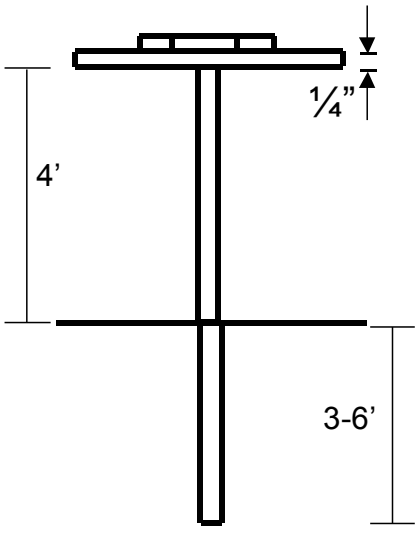

Figure 6: Dimensions of a picture post

The construction of the picture post is quite simple. A four-foot wooden or metal post is cemented three to six feet below the finished grade to protect from frost heave during the winter. From there, a quarter-inch thick circular disk with a diameter between eight to ten inches is fastened to the post. Placed in the middle of the disk is a quarter-inch thick octagonal backstop that is approximately five inches from side to side. The material used is a major issue that each organization needs to address based on funding, interest in the project, and length of

time that the post will be in use. Different techniques will be necessary to fasten the disk to a wooden post versus to a metal post. For a wooden post, wood screws are sufficient to get the job done. However, for a metal post, either welding or sheet metal screws may be used. Welding would be more permanent and secure, but would also cost substantially more. On the other hand, fastening the plate to the post with screws would be much cheaper, but would be inviting to vandalism in a public park. In addition, metal posts would cost up to $500 per post, whereas wooden posts will cost significantly less, approximately $50.

However, if a wooden post is going to decompose and deteriorate in two years while a metal post will endure for a couple of decades, the organization must make a logical decision. If a program plans to make use of a picture post for twenty or more years, then maybe it is much more sensible to spend the extra money on a metal post opposed to buying a new wooden post every year or two. As far as testing and experimenting is concerned, wooden posts are much more logical due to the low cost and rate of construction. Once the organization constructs and strategically places the picture posts around their reservation, high quality digital imagery may be collected and analyzed.

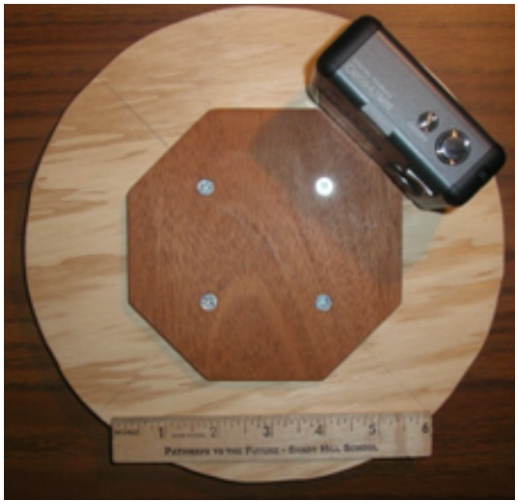

Figure 7: Picture post prototype

A well-placed picture post can provide years of quality images that can be analyzed by scientists to gain a better understanding of our environment. The idea is to place a digital camera centered flush against one side of the octagon plate. If this is accurately done for all eight sides, then a complete 360˚ image can be created by simply taping the photos together in proper order. The great thing about this data collection method is that once the post is set up, anybody with a digital camera can take advantage of it. (In addition, filtered lenses can be attached to the camera to better examine vegetation health and reflectance, as we will see later in this chapter.) Many

environmental changes that may otherwise go unnoticed will be observed through this advanced digital imagery technique.

4.3.3 Time-Lapse Film

As a community, we take many natural and environmental phenomena for granted. In many cases, these occurrences become so commonplace, that we altogether miss the everyday awe and beauty of our surroundings. For instance, imagine it is early May in a picturesque New England. The first leaves on the trees are beginning to spring up. Although this fact is very obvious and apparent to most citizens, it becomes overlooked because it is an annual occurrence. However, through the use of a time-lapse film, we can observe such natural phenomena and make informative analyses in an educational and exciting manner.

Figure 8: Seasonal changes of Black's Nook at Fresh Pond

Having the technology to observe changes over time in a streaming video is significant in the efforts of gaining a better understanding of our environment and the interactions that take place in it on an everyday basis. By setting up a digital camera in a secure spot for an extended period of time, many observations can be studied that would otherwise go undetected through regular daily monitoring. We can see such things as vegetation growth, animal interactions, cloud cover, climate change, shadowing, and seasonal changes. For example, through viewing a time-lapse film from a digital camera that was set up to take one image every ten minutes for one full month during the spring, we can observe many environmental issues and occurrences. We can see exactly how long it takes for a tree to fully green up, what times of day the leaves grow the most, what weather is most ideal for plant growth, and how the sunlight affects the direction of plant

growth. In addition, by viewing similar films from year to year, we can make accurate presumptions about each of these occurrences and other environmental incidences. Understanding our environment and how it changes on a daily basis is essential in our attempt to have a full appreciation and awareness for the interactions that take place among our surroundings.

4.3.4 Filtered Lenses

In the world of science and technology, many significant environmental observations cannot be made by the human eye. A large part of the electromagnetic spectrum and its relationship to the world around us is invisible because we are limited to seeing electromagnetic wavelengths that extend only from those characteristic of violet-blues to those of deep reds. By adding photographic materials to a camera, such as filtered lenses, we can broaden our vision of our environment and the interactions transpiring in it.

Many environmental issues cannot be observed by the human eye, yet are very apparent when seen through a filtered lens, such as with the infrared. Infrared light lies between the visible and microwave portions of the electromagnetic spectrum. The primary source of infrared radiation is thermal radiation; therefore, any object that emits thermal energy can be observed in the infrared. When applied to our environment, the infrared film 'sees' an object because the sunlight is being reflected or absorbed by the object. In vegetation, chlorophyll is the factor that determines the intensity of 'green' that is seen in the visible light. Therefore, the 'greener' the vegetation is in the visible light, the more reflectance will be shown in the infrared light. Since chlorophyll is necessary for photosynthesis, which is the basis for sustaining the life process of all plants, we can deduce the health of a plant based on the reflection of light seen in the infrared. Therefore, as seen in Figure 9, the

Figure 9: Stress detection in vegetation

more infrared light that is reflected (brighter), the healthier the plant is. Conversely, the more infrared light that is absorbed (darker), the more stress the plant is experiencing.

Understanding and appreciating this information is valuable to the scientific community. By recognizing reflection of infrared light through a filtered lens, we can identify early signs of stress detection in plants from disease, drought, flooding, air quality, pests, and/or wintering. Having the ability to examine environmental concerns that are not apparent to the human eye will prove to be significant in the progression of our knowledge of science and our environment.

4.3.4.1 Cost and Specifications

There are many different types of infrared lenses available to purchase. Since the majority of images that will be taken for environmental purposes will be under sunlight, it is suggested that a 1000 nm filter is used. It is imperative to know the diameter of the lens on the camera in order to purchase the correct corresponding filter (this diameter will be labeled somewhere around the front of the lens). We found that the majority of infrared lenses were selling between $50-$75. In addition, these filtered lenses may be applied to both picture post photography and time-lapse films, providing even more advancements for science, technology, and our environment.

4.3.5 CyberTracker

With increasingly significant human impact on the environment, and the possibility of sudden, unpredictable changes in ecosystems due to habitat destruction and climate change, a key concern is how we can detect problems in the environment before it becomes too late to reverse them. Ongoing monitoring of our environment that produces large quantities of data makes it possible to detect problems in their early stages. CyberTracker combines modern science and local knowledge with state-of-the-art computer and satellite technology to better observe our surroundings. The mission of the *CyberTracker Conservation* is to "promote the development of a worldwide environmental monitoring network."[36]

[36] CyberTracker. [Internet] [Cited 2005 April 19] Available at http://www.iapad.org

CyberTracker Software provides "the most efficient method of field data collection, even by non-literate users, at a level of detail not possible before."[28] With CyberTracker Software, scientists and other field workers can generate their own data entry template, or screen sequence, and use it on a handheld computer (Windows Mobile PocketPC or PalmOS) with GPS capabilities to gather and map an unlimited amount of data.

Although CyberTracker's unique design allows users to display both icons and text, the software is far more image-based. Over 700 environmental icons symbolizing various animals, along with their markings and actions, are included with the software, allowing both school children and illiterate people to collect field data. The CyberTracker program emphasizes the following advantages: free software benefiting conservation and research; paperless field data collection reducing errors and waste; no programming skills required; immediate mapping of collected data; and facilitated export for analysis.

4.3.5.1 CyberTracker Application

CyberTracker has recently been introduced to uncivilized and illiterate hunting tribes in Africa in hopes of better understanding and mapping the various species of animals inhabiting the area.[37] These hunting tribes were specifically sought out due to their unparalleled knowledge of the area, which is necessary for their survival. After visually being shown how to use the handheld computers and the CyberTracker Software, the natives went out for two weeks and gathered as much information as possible

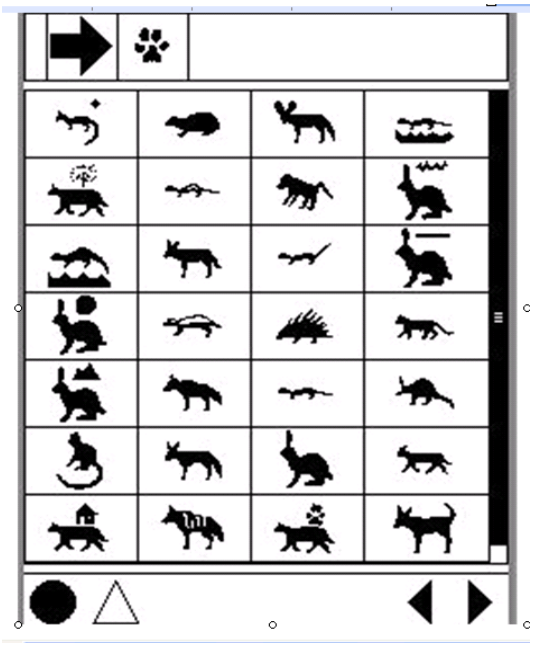

Figure 10: Icons displayed from CyberTracker

[37] CyberTracker. [Internet] [Cited 2005 April 19] Available at http://www.iapad.org

while hunting for their food. They observed and recorded such data as what types of species of animals they witnessed, what types of markings they left, and what actions they were doing. Each time an animal was seen, the tribe would locate the corresponding icon on the software and press it. The handheld computer then saved the location of the observation through the GPS system.

Upon their return, the scientists exported the collected data from the CyberTracker system to a Microsoft Access database, then to a Geographical Information System (ArcView). After analyzing the results, the scientists were in disbelief of what they encountered- the tribe had successfully observed and recorded more species of animals during their two-week venture than the scientists had in six months. This is yet another example of how citizens can effectively collect large amounts of quality data by using new and innovative data collection techniques.

4.3.5.2 Cost and Specifications

The actual CyberTracker Software itself can be downloaded from the Internet free of charge; however, commercial users who find this software useful are encouraged to donate money to the *CyberTracker Conservation*, a non-profit organization responsible for implementing field projects and promoting a worldwide environmental monitoring network. Therefore, the major components one must have to fully utilize the system are a personal computer, a handheld computer, and a Global Positioning System receiver. CyberTracker is installed onto the personal computer and then uploaded to a handheld computer. Using a GPS, one can geo-reference and map the collected data. After collecting the data onto the handheld computer, the information can be exported to a database system such as Microsoft Access on a personal computer. The handheld computer, which can either be a Windows PocketPC or a PalmOS, usually cost between $250-$450. The Global Positioning System, which is optional, runs around $300.

4.3.6 Digital Imagery Analysis

The digital imagery analysis software that is included has a series of programs that use different color and image analysis techniques. Appendix Q includes a letter from

the developer that outlines how to use the software, as well as provides a summary of everything that is on the disk.

The software is easy to learn and can be used by anyone, from school children to professionals. The activities on the CD take you through the basic idea of color, and the different role color plays in pigment and light. These ideas are fundamental to the rest of the activities, and for the basic understanding of the image analysis tools. For example, one activity involves altering the colors that are shown in a picture, and it is important to understand how colors mix to properly interpret the picture. There are also special tools to determine areas of irregularly shaped objects, which can be done by setting it to select the pixels that contain a certain range of color. Another special activity is a picture merge that allows one to merge time-lapse pictures into one.

There is great potential for this program with both teachers and scientists, because it is simple enough for school children to use and advanced enough to benefit professionals. The following two sections describe two different functions of the image analysis program included on the software, which is just one of many useful programs.

4.3.6.1 Measuring Area

The GSS Interpreting Digital Images (GSS IDI) software has a unique technique for determining the area of an object. First, there must be a digital picture of the object available that has a scale in it. This could be a ruler place in the picture, or just an object of a known size. The first thing that you must do after loading the picture is size calibration. There is a line tool that you must use to draw the scale onto the picture, as can be seen on the example in Figure 11 on the right. The line drawn is 4 inches, and so that measurement is inserted into the size box, and the size calibration is complete. From that, the program can determine the size of each pixel,

Figure 11: Calibrated image using line tool

which will allow further measurements to be pulled from the same picture. For the most part, pixel size calibration is preparation work for figuring out the area of an object.

The next step is contingent on the background of the image, because it should be a solid color that contrasts from the object in the image. The leaf pictured above illustrates this idea, as the dark leaf stands out from the light colored background. Using an area tool, you can select a random square sample from the leaf, which will then highlight all of the pixels within the square. From there, you must adjust the color range that is highlighted so that it will include all of the leaf, but none of the background. This can be done simply by playing around with each color range and testing it until it includes all of the leaf. It should not require too much tweaking due to the previous step of highlighting a box of pixels already in the leaf. Once the entire leaf is highlighted, the last step is to use the area tool one final time to draw a box around just the leaf, as seen in the image on the left. This allows you to single out just the highlighted pixels that are part of the leaf, because other pixels may also get highlighted in the process, for example, in this instance the ruler is within the color range so it became highlighted too. Now since the background is white, the program will automatically calculate the area of the black highlighted pixels within the box, giving you the area of the leaf.

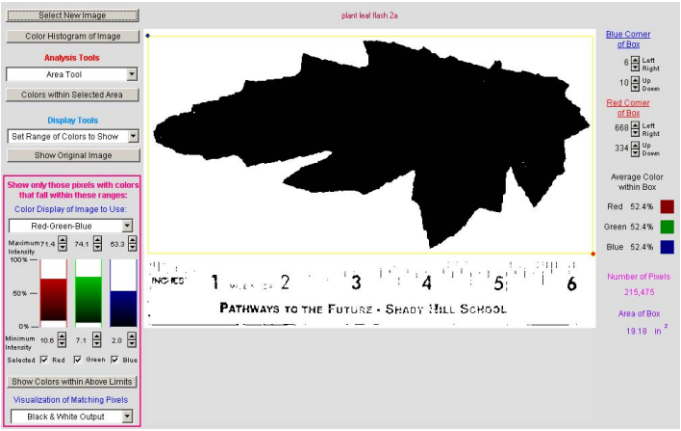

Figure 12: Color adjustments in digital imagery analysis software

This tool can not only be used for determining the area of a leaf, but pretty much the area of anything as long as the picture is set up right. With the right preparation work, this program can be used to analyze anything, from the change in growth of a leaf, to the change in growth of the wingspan of a penguin. It provides very useful information to professionals, but also provides a good hands-on learning tool for students.

4.3.6.2 Color Analysis

The same program used for determining area can also be used to do a variety of color analysis. There is a drop down menu that allows you to select what color the image is shown in, and each color means something a little different. The woman in Figure 13 is shown in red, blue, and green light, and appears exactly as she would in the visible light. However, if the color is changed to display just the blue, as in Figure 14, she looks much younger.

Figure 13: Woman in visible light

Figure 14: Woman in blue light

Everyone appears youngest in blue light because the blue light only displays the top layers of skin. Red light has just the opposite affect, making her look even older in Figure 15 because it shows the deeper layers of skin and you can start to see a little bit of sun damage here, although it is not actually visible in the visible light.

This program has a variety of functions for color analysis, which is what makes it so versatile. While the example above shows how it can be used quickly and easily in medical fields, it can also be used to analyze vegetation health. Plants also look different in different light, and you can determine the health of the plant because it will not reflect as brightly in other lights, thus showing signs of stress detection.

Figure 15: Woman in red light

4.4 Databases Used by Citizen Science Programs

Programs all over the United States and Canada were interviewed to determine what kind of information systems they have been using in conjunction with their Citizen Science efforts. The results of these interviews can be found below.

4.4.1 Geographic Information System

A geographic information system is most commonly referred to as GIS. GIS, simply put, is a computer mapping system. This program has a vast amount of usages, allowing one to interact with maps and manipulate them in unique ways. There is excellent potential for GIS to be used in the future in conjunction with Citizen Science programs, yet currently it is still fairly cutting edge technology and remains fairly unknown.

Citizen Science programs can reap the benefits of a system like GIS because of its ability to include so much detail. GIS is based on different layers, and one can zoom-in on some maps to different levels. For example, looking at a satellite image, one can zoom-in to his/her own street level and see an actual image of their house and their neighborhood. This same idea can be used to benefit different organizations, but instead of having satellite maps of towns, there could be aerial photos of parks. By clicking anywhere within that picture, one would be able to zoom-in to various objects, potentially all the way to the leaf level.

A system like this is hard to upgrade because it requires a lot of special attention for the different map sets that are used. While some organizations are only able to update their maps every six months or so, an ideal situation would be continually updating them on a monthly basis. Though the upgradeability for this type of system is not excellent, it makes up for it in its easy maintainability and its extreme user friendliness.[38]

4.4.1.1 The Nature Mapping Program

The *Nature Mapping Program*, a new program run out of the University of Washington, relies on a GIS system that is maintained by one of its own staff members.

[38] Your Internet Guide to GIS [Internet][Cited 2005 April 19] Available at http://www.gis.com/index.html

They chose this system because they were looking for something that would allow people to ask questions and get answers back graphically. In addition to that, data systems were becoming far too expensive for them so they wanted to make it internet-based.

Currently the system is not very advanced, and they would like to develop it so that it is fully functional with the ability to focus in on individual objects. Soon this will be available through their website so that everyone may have access to it. This system will be free for public use, and will not require a login or a password, making a great wealth of information available for the public. The program is easy-to-use, allowing anyone to take advantage of what it has to offer, regardless of age or experience.[39] (See Appendix R)

4.4.2 Oracle Based Systems

Oracle is considered to be one of the most sophisticated database systems available today. As a result of that, it is also one of the most expensive. The programs below have all weighed the pros and cons of using a system like this, and have all decided on Oracle.

Though extremely expensive, Oracle remains a top option for many because it has a large capacity for data. This type of system depends on a server that hosts all of the information in one centralized location. "Keeping your Oracle database systems highly available takes knowledge, skill, and experience. It also takes knowing that each environment is different. From large companies that need additional DBA [database administrator] support and specialized expertise to small companies that don't require a full-time onsite DBA, flexibility is the key."[40] The larger the organization is, the more technical staff they will need to administer the database. Overall, Oracle ends up being fairly expensive, user-friendly from the front end, but not very user-friendly from the back end, and a little bit more difficult to maintain than most databases. However, not being user-friendly on the back end, and the difficulty in maintaining the system, can be addressed by an experienced database administrator who works full-time on it.

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[39] Karen M. Dvornich, interview by author, Boston, Massachusetts, 5 April 2005.
[40] Database Pro [Internet][Cited 2005 April 27] Available at http://www.dbspecialists.com/brochures/DBAProDataSheet.pdf

Some organizations see information as money, so they will allow other organizations to store information on their server, as long as they are allowed to use the data. This server sharing can be witnessed more and more as people shift towards more web-based system.

4.4.2.1 Worm Watch

Worm Watch, one of the most advanced programs we have talked to, relies currently on an Oracle database; however, they are looking to move towards an open GIS system. Their system now has been customized for them, and is ready for data-entry. The system was designed so that it is easy to use, this way anyone from school children to adults can add in data that they gather. Currently, *Worm Watch* pays $10,000 in licensing fees annually. Though typically Oracle can be difficult to maintain, *Worm Watch's* technical staff allow them to keep their system entirely upgradeable. So on top of the licensing fees, the cost of a good database administrator must also be figured in.

The cost of using an open source GIS system is nothing, because open source means that the code is available to anyone. The upside of the GIS system is that data would be more freely available, and at a much cheaper cost to the organization. However, they would still have to figure in costs for an IT worker to upgrade and maintain the system. There are currently several open source GIS systems available that can be obtained from the World Wide Web.[41] *Worm Watch* is considered to be a small part of *Nature Watch,* and all of their information is actually stored on the *Nature Watch* server. They encourage other people to submit data to them, and are willing to store anything that is nature related on their server. (See Appendix S)

[41] Open Source GIS [Internet][Cited 2005 April 19] Available at http://opensourcegis.org/

Figure 16: Worm Watch's Oracle data entry log-in screen

4.4.2.2 Cornell Lab of Ornithology

Cornell's Lab of Ornithology, a large organization that has been successful for many years, also has a customized Oracle system to fit their needs. Like *Worm Watch,* they are collecting a large amount of data and want it to be easy to enter and easy to use by the volunteers who collect the data. They were drawn to the system because it was server based, therefore they would be able to store a lot of information, as well as its cost effectiveness. So far they have no complaints about their system, and they have been using it for the last six years. The only downside is the maintainability of it, as it is constantly being upgraded and requires a full-time staff member to be in charge of maintaining it.[42] (See Appendix T)

[42] David Bonter, interview by author, Boston, Massachusetts, 6 April 2005.

4.4.2.3 MIT's Collaborative Mapping Initiative

MIT's *Collaborative Mapping Initiative* has just been founded, and although they have not yet established a database system yet, they are currently leaning towards using Oracle. The other option that they are considering is FileMaker Pro.[43] (See Appendix U)

4.4.3 MySQL

MySQL has been a popular choice for years now because it is an open source system and because it can be very powerful in data retrieval. "The particular appeal of MySQL for web development is in its small footprint and incredibly fast retrieval of data. It is most appropriate for enterprises that do a low level of table updates and insertions and a high level of data retrieval."[44] Though speedy with data retrieval, this system's downside is definitely its upgradeability, because it is not that easy to update. Regardless of that, it can be run off of pretty much any operating system, which allows for a lot of flexibility with system requirements.

4.4.3.1 Journey North

Journey North, a large organization that has been around for many years, uses MySQL, which is a Unix-based database system. This program is fairly expensive, costing them around $1500. They have over ten years of data on bird migration currently stored, confirming the system's reliability. However, they do not recommend this system unless one has a full-time programmer on staff to devote time to this database, as it requires a lot of system maintenance. Not only is this system hard to upgrade and maintain, it is not considered to be very user-friendly either.[45] (See Appendix V)

4.4.4 Microsoft Access

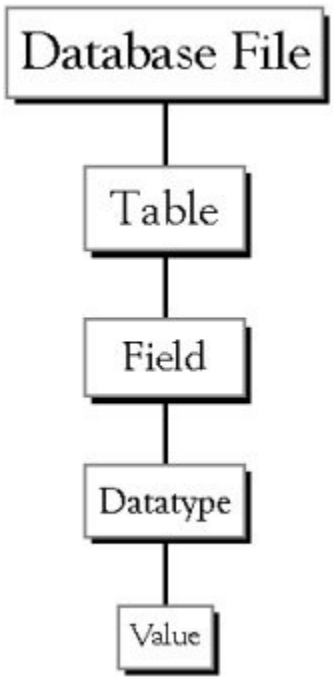
Microsoft Access is a database program that is part of the standard Microsoft Office package. Unlike the larger databases, everything associated with Access is stored

[43] Debbie Douglas, interview by author, Boston, Massachusetts, 7 April 2005.
[44] ACCU Reviews: MySQL [Internet][Cited 2005 April 27] Available at http://www.accu.org/bookreviews/public/reviews/m/m002374.htm
[45] Joel Halvorson, interview by author, Boston, Massachusetts, 7 April 2005.

and run locally, not from a server. The following are the system requirements: Personal computer with an Intel Pentium 233-megahertz (MHz) or faster processor (Pentium III recommended), 128 MB of RAM, and 180 MB of hard-disk space. Access is also considered to be fairly user friendly, as there are wizards to assist with almost every different function. "A variety of step-by-step wizards makes it easy to build and manage databases in Access. If you're unfamiliar with databases or you just want to put something together without a great deal of effort, these wizards are just what you're looking for."[46]

4.4.4.1 Adirondack Cooperative Loon Program

The *Adirondack Cooperative Loon Program* relies on a Microsoft Access Database system to store all of its information. They choose this program because of its ability to easily transfer data and because of its availability. Though it is useful for them, it would not be useful for many other programs, as it is not connected to the Internet and



Database File: This is your main file that encompasses the entire database and that is saved to your hard-drive or floppy disk.
Example: StudentDatabase.mdb

Table: A table is a collection of data about a specific topic. There can be multiple tables in a database.
Example #1: Students
Example #2: Teachers

Field: Fields are the different categories within a Table. Tables usually contain multiple fields.
Example #1: Student Last Name
Example #2: Student First Name

Data types: Data types are the properties of each field.
A field only has 1 data type.
Field Name: Student Last Name
Data type: Text

Figure 17: Components which make up Microsoft Access Database

[46] PC Magazine Reviews [Internet][Cited 2005 April 27] Available at http://www.pcmag.com/article2/0,1759,41815,00.asp

has a limit on how much data can be stored. For this particular purpose, they are using it for less than one hundred megabytes of data storage. They do not have an on-staff technician, instead they rely on reading the manual for any upgrading or training that needs to be done.[47] (See Appendix W)

Microsoft Access is considered to be fairly average when it comes to its user-friendliness, maintainability, and upgradeability, however it is specific to each project that it used for. This type of database can really only handle around one hundred images before it starts to become inefficient; so for organizations that rely on the storage of images, this database is not recommended.

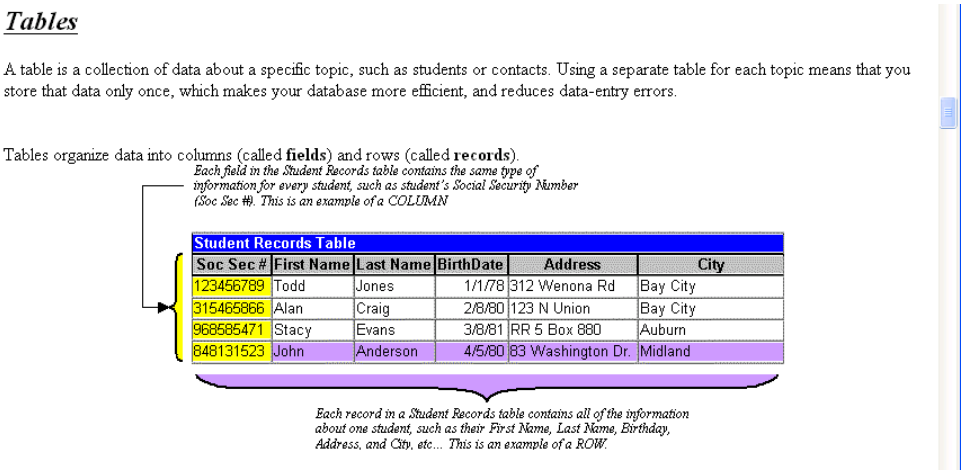


Figure 18: Example Microsoft Access data entry form

4.4.4.2 MDI Water Quality Coalition

Mount Desert Island Water Quality Coalition, a non-profit organization, has been around for several years and has been using Microsoft Access for seven of those years. They found this to be the most useful option for them, as they already utilized Microsoft Office and Access came as part of it. Sometimes the system is hard to maintain, but that is due in part to the fact that no one on the staff has had any formal training on the software. They are considering having a consultant come in to teach everyone for a day, which would certainly alleviate some of the program challenges they have encountered.

[47] Nina Schoch, interview by author, Boston, Massachusetts, 8 April 2005.

Overall though they found this program to be very easy to use once they got the hang on it, and they would recommend it over Microsoft Excel for information storage.[48] (See Appendix X)

4.4.5 FileMaker Pro

4.4.5.1 New England Household Pests

New England Household Pests based out of Harvard University relies on FileMaker Pro for its database. They have been using this program for approximately ten years now, and it cost them around $300. The program is very easy to use and requires almost no training for use. The main reason for choosing this system was the fact that it was designed with the sole intent of storing bigger files such as images, rather than just text, and therefore it is more equipped to handle a lot of images than any other standard database. Currently they use their system to store information on almost every insect and their database includes over one thousand pictures.[49] (See Appendix Y)

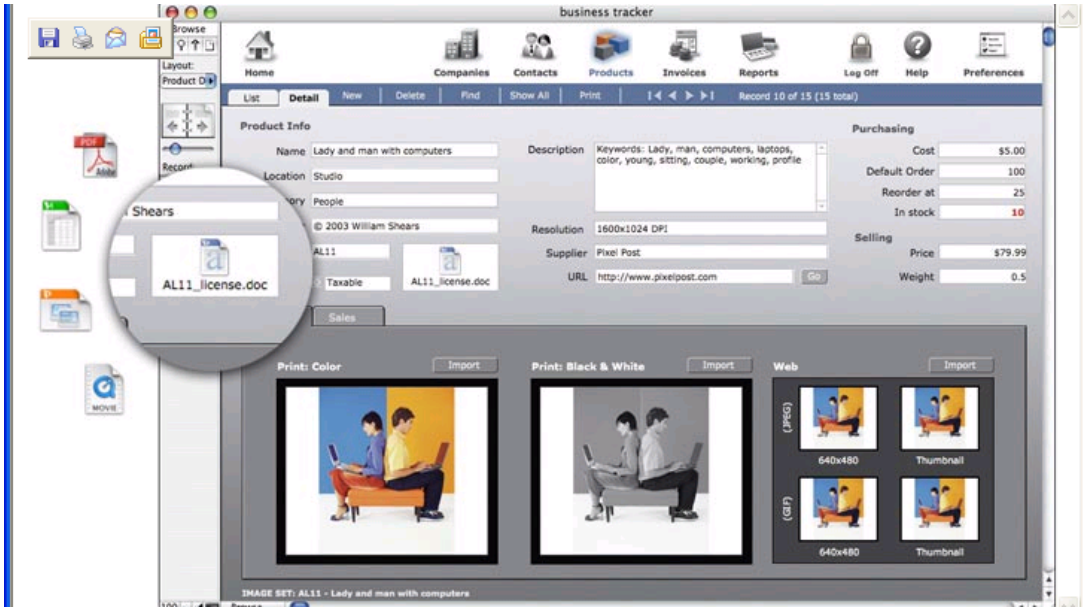


Figure 19: FileMaker Pro example layout containing pictures and text

[48] Jane Disney, interview by author, Boston, Massachusetts, 26 April 2005.
[49] Gary Alpert, interview by author, Boston, Massachusetts, 7 April 2005.

Though this piece of software is initially expensive, it is not very expensive to upgrade it and it can easily be done right through the FileMaker Pro website. Additionally, one can download a free trial version from the website to give it a test run to see how he/she likes it. The ratings on this software are excellent, beating out several of its competitors for awards. Law Office Computing's review of it seems to really capture what everyone else is saying about it as well; "FileMaker Pro 7 brings powerful new features and scalability in a complete rewrite of this relational database for OS X. There are new ways to examine relationships between tables, a revamped interface for creating databases and dozens of subtle but important improvements. File size, text fields and container capacities have increased enormously. You also can import and export more file formats. The application, however, maintains its familiar, easy-to-use interface."[50]

[50] FileMaker: Product Reviews and Awards [Internet][Cited 2005 April 20] Available at http://www.filemaker.com/company/newsroom/news/product_reviews.html

4.4.6 Thumbnails

4.4.6.1 Cape Cod National Seashore

Cape Cod National Seashore currently deals with a lot of images, so they have opted to use a piece of software called Thumbnails. Though this is not data storage software, it does help to convert each image to the same file type and size quickly and easily to help provide some uniformity. Since they are still lacking a forum to store all of their images, they would be willing to consider any new proposed systems.[51] (See Appendix N)

4.4.7 Servers

Often one can have his/her information stored for free depending upon the kind of data he/she would like stored. For example, *Worm Watch* is considered to be a small branch of *Nature Watch*, and so all of *Worm Watch's* information is stored on the *Nature Watch* server. Additionally, anyone who has any information about nature is welcome to use their servers for free, assuming that *Nature Watch* is allowed to utilize the data as well. Other organizations are willing to work out similar deals with people as well, because it is a situation both parties can benefit from.

Worcester Polytechnic Institute (WPI) is currently considering a possible solution for data storage. WPI has a plentitude of storage, and could easily devote a server for the storage of Citizen Science related information. Since Citizen Science programs would be the ones actually collecting all of the data, they would be rewarded for their hard work by receiving free storage. In fact, due to the increasing migration of all systems to become web-based, most programs would not have to worry about anything being stored on their own systems. Instead, everything they had could be stored on a server at WPI.

Dr. Fabio Carrera, Director of the Boston and Venice Project Centers for the Interdisciplinary and Global Studies Division at WPI, sees a lot of potential in this possibility. Through a grant, WPI could easily obtain the funding to establish this server, and a graduate student could be compensated for maintaining and upgrading the server. This is just one of the many possibilities when it comes to data storage, but it does

[51] Barbara Duggan, interview by author, Boston, Massachusetts, 23 March 2005.

provides Citizen Science programs with some options, especially ones that allow them to stay in line with today's technologies via the web without compromising their time and money.[52] (See Appendix Z)

4.4.8 Other Systems

4.4.8.1 Friends of Acadia

Dreamweaver is an advanced website editing software produced by Macromedia. It uses a combination of HTML and WYSIWYG to produce leading web designs.[53] Currently, some of the Citizen Science programs that have been investigated do not have a database system that they rely on to store their information. The closest they are to being technological is having fairly advanced websites that were created with Macromedia Dreamweaver. For example, *Friends of Acadia* located in Maine does not have a data collection system currently set-up, however they previously used Dreamweaver to create their website. [54] (See Appendix AA) Though these organizations don't have databases now, they are very interested in establishing them in the near future.

4.5 Interactive Decision Tree

The Interactive Decision Tree is a resource designed to assist Citizen Science programs in deciding the most appropriate database based on their personal preferences and limitations. The ultimate goal of the program is to provide insight about the most commonly used systems in North America through descriptive insights about their capabilities, cost, maintainability, user-friendliness and other important characteristics. Our hope is that the interactive piece will offer a more simplistic in-depth look at the possibilities for advancement by incorporating a database system to fit the needs of individual organizations.

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[52] Fabio Carrera, interview by author, Boston, Massachusetts, 8 April 2005.
[53] Macromedia Dreamweaver [Internet][Cited 2005 April 4] Available at http://en.wikipedia.org/wiki/Dreamweaver
[54] Mike Staggs, interview by author, Boston, Massachusetts, 7 April 2005

The decision tree is an interactive computer-based program designed in Microsoft PowerPoint. The specific qualities that make up the tree are layered into 5 or 6 tiers, depending on the programs storage preference. The setup of the questions within the program is as follows:

- Storage type
- Picture capacity (if necessary)
- System Requirements
- Cost
- Ranking program preferences
- Database Recommendations

(See CD Attached for Interactive Decision Tree)

Instructions for Use:

To run the Interactive Decision Tree

1.) Select the icon displayed when viewing the CD folder

or

2.) Copy the folders onto your computer's hard disk and select the icon.

3.) Once the program is open follow the instructions initially prompted to you.

4.6 Process for Self-Evaluation

To produce recommendations for programs, a self-evaluation process was created for programs to assess their current mechanisms. The process consists of a questionnaire, which should be answered individually based upon the specific makeup of the organization. At the time of completion, a recommendation is produced based upon the results of the self-assessment.

4.6.1 Self Evaluation

4.6.1.1 Step One

Please answer the questions below based solely on the makeup of your organization. Use the color scale below to realistically determine the right answer for your program.

(This self-evaluation questionnaire can be seen in Appendix BB)

The recommendation produced will be based on the number of green, yellow or red markings the organization has evaluated itself with. After the assessment, if you have ranked yourself with,

All green: You're on track! You have met the essential requirements needed for the foundation of a Citizen Science program. Please move on to step two below.
Mostly green with occasional yellow and red: Your program is very close to meeting the necessary components for a strong foundation for a Citizen Science program. The areas in red need immediate attention to continue, and the areas in yellow will be cause for struggle. Before moving on to the second step, we recommend you first fulfill these gaps in yellow and red. At the time the gaps are filled, re-evaluate using the questionnaire and find out your new assessment recommendation.
All yellow: The yellow areas can be defined as places of weakness, without each of these components in place your program will struggle. Once you feel that you have enhanced these areas, re-evaluate your program using the questionnaire and find out your new assessment recommendation.
Mostly yellow with occasional green and red: Your program is missing many essential keys in its foundation. These are necessary in moving forward, and it is recommended that each of these components be fulfilled before moving forward. Once you feel that you

have repaired and enhanced these areas, re-evaluate your program using the questionnaire and find out your new assessment recommendation.

All red: Your program is missing all essential keys to its foundation. These are necessary in moving forward, and it is recommended that each of these components be fulfilled before moving forward. Once you feel that you have enhanced these areas, re-evaluate your program using the questionnaire and find out your new assessment recommendation.

Mostly red with occasional green and yellow: Your program is missing nearly all essential keys to its foundation. These are necessary in moving forward, and it is recommended that each of the red and yellow components be fulfilled before moving forward. Once you feel that you have enhanced these areas, re-evaluate your program using the questionnaire and find out your new assessment recommendation.

Mixture of greed, yellow and red: Your program is not balanced and is missing many essential keys to its foundation. These are necessary in moving forward, and it is recommended that each of the red and yellow components be fulfilled before moving forward. Once you feel that you have enhanced these areas, re-evaluate your program using the questionnaire and find out your new assessment recommendation.

4.6.1.2 Step Two

Since the program has received the recommendation to continue moving forward, it has met the majority of the crucial standards for initial success. The group next recommends they review the following material in order of appearance:

1.) Marketing and Advertising Techniques (Appendix DD)
2.) List of Activities (Appendix FF)
3.) Interactive Decision Tree
4.) Citizen Science Guidelines (Appendix CC)

4.7 Citizen Science Guidelines

The Citizen Science Guidelines are a chaptered collection of research and results that provides insight on the various stages of a Citizen Science program. The guidelines have been broken down into six chapters for organizations to easily access the particular

information they are seeking. They include: a self-evaluation for programs to assess themselves with; marketing and advertisement techniques; an index of current Citizen Science programs along with the data they collect, what the data is used for, and activities for they use; new and innovative data collection techniques; an interactive decision tree; and numerous database descriptions. For the guidelines, see Appendix CC.

5 Conclusions and Recommendations

The main focus of this project was to study opportunities and challenges for the advancement of Citizen Science programs. After conducting interviews to learn general information about both citizens, scientists, and programs, we analyzed the information and presented it in a way that would help further Citizen Science programs. This section discusses the conclusions and suggestions that were produced from the information that was gathered and analyzed. Through analysis, we have produced specific recommendations for both our sponsor and local Citizen Science programs.

5.1 Citizen Science in North America

5.1.1 Conclusions

After conducting in-depth interviews with twelve programs throughout North America, the group was able to gain an understanding for the various types of data being collected as well as the levels of participation. Overall, we have concluded that the successes of Citizen Science efforts are contingent on three main factors:

- Level of advertisement/marketing
    - How many participants are involved in their program?
    - What methods of advertisement do they use?
- Data collection techniques
    - What type of data do they collect?
    - What methods do they use?
- Data analysis and dissemination
    - Who uses their data?
    - What type of database do they use?

5.1.2 Recommendations

Based upon our results and conclusions, the group recommends suggestions for both underdeveloped organizations and advanced programs. These recommendations were created based on what the group considered to be the most ideal outcome for a Citizen Science program.

5.1.2.1 Recommendations for Underdeveloped Citizen Science Programs

To increase the level of volunteer and community participation, the group has produced a chart of possible advertising and marketing techniques, which can be a useful resource for programs that are looking to expand the number of interested participants (See Appendix EE).

To educate underdeveloped programs of the various data that are being collected, a table was created containing information on numerous Citizen Science programs in North America, the type of data they collect, and how the data collected is being used (See Appendix FF). This can be particularly useful to gain an understanding of the successes of a specific organization based on the data being collected. This will also provide a practical base to learn about what particular data is used by scientists to produce results.

We recommend that underdeveloped programs:

- Refer to the *Advertising and Marketing Techniques Chart* (Seen in Appendix EE) to recognize new ideas for gaining volunteer interest through various techniques which have proved to be successful for numerous Citizen Science programs
- Refer to the *Citizen Science Data Type Chart* (Seen in Appendix FF) and *List of Citizen Science Activities* (Seen in Appendix GG) to learn about other programs who collect similar data in order to identify alternative activities and methods for data collection

5.1.2.2 Recommendations for Developed Citizen Science Programs

We recommend that developed Citizen Science programs:

- Continue to attract new volunteer interest to expand the growth of Citizen Science programs worldwide
- Continue to advance their programs through advertisement, especially by making their progress and results easily accessible for others to view
- Provide assistance to underdeveloped programs; the overall result will be a worldwide increase in the environmental monitoring

5.2 Innovative Data Collection and Analysis Techniques

Through identification and experimentation of various types of data collection methods, we have determined the most valuable techniques for Citizen Science programs. Organizations can utilize the various practices on different levels based on the budget of each program. Each of the methods for collecting digital images (picture post photography, time-lapse film, and filtered lenses) will provide essential and repeatable environmental data; CyberTracker offers an easy-to-use program for tracking the actions and tendencies of various species of plants and animals; and the digital imagery analysis software presents a new approach to study digital images through color analysis.

If an organization was interested in examining their environment as a 'big picture,' then picture post photography would be the best method to pursue. By taking several pictures from the same location at different angles, one would be able to piece them together to form a unique perspective of the environment that would be subject to change over time. As previously mentioned, construction of the post with different materials varies the price: metal costs approximately $500 per post, while wood costs no more than $50 per post. This technique will provide a unique and distinctive panorama of our surroundings.

One technique that is very beneficial when attempting to observe changes over time is time-lapse filming. Set up a digital camera in a desired location for an extended period of time, and set the camera to take pictures at certain increments of time. After the

camera has been setup for a week, month, or year, observe the photos in a streaming video to study the various environmental interactions and occurrences taking place.

Through the use of filtered lenses, such as infrared, one can study stress detection in different types of vegetation. These lenses, which generally run between $50-$75, can also be applied to both picture post photography and time-lapse films.

If an organization was interested in the tracking of various types of plants and animals, along with examining their patterns of living and everyday tendencies, then the CyberTracker program may be of use. The program itself may be downloaded free of charge from the Internet; however, some major purchases are necessary for optimal results. The handheld computer that the program must be uploaded to will cost between $250-$450. Although it is optional, a Global Positioning System receiver can be purchased for about $300 if one is interested in mapping the results through a Geographical Information System. Additionally, the collected data must be exported to a database. Microsoft Access, which is sufficient for this program, comes as a component of Microsoft Office with most personal computers.

The digital imagery analysis software, created by our sponsor, is a very useful tool when dissecting digital images. Color and area analysis are both valuable to environmental studies (vegetation growth), and for educational purposes. Currently, the software is free of charge and is provided with this report in Appendix O.

5.3 Databases and Decision Tree

Our interactive decision tree model was created as a basis for citizen science programs to use when selecting an information system. All of the questions and recommendations within the model are based on our research of citizen science programs of varying success levels throughout North America, interviews done with those specific organizations, and research on the different databases those organizations used. Through those interviews, we were able to determine what components were important to people when they were selecting software. We also asked people to evaluate their system and to list its strong points and weaknesses. Those components and evaluations have allowed us to put together a model that we believe will be extremely helpful to many organizations.

The reasoning behind the creation of this model was that people know that there are different databases out there, but they have no idea what components are important and how to make a decision. We wanted to simplify this process for them by coming up with a very easy process to follow to get a customized recommendation. There are simple instructions included with the model for people to follow, and after answering all of the specified questions specific to their own organization, they will receive a proposed system to use.

Our recommendation for all citizen science programs is to refer to our decision model CD located in Appendix BB, and to also refer to our citizen science guidelines that we have produced, located in Appendix DD. We believe that the decision model will help determine a database that is right for them, and our manual will help provide some guidelines to keep their program on the right track. These elements will challenge programs to evaluate their current state and determine what can be changed. In this way, we are providing citizen science programs with the tools to make their programs better.

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Appendix A: Citizen Science General Interview

Name of Organization:		
Date:		
Email:		
Phone number:		
Speaking to:		
Interviewed by:		
QUESTIONS:		**ANSWERS:**
Background:		
When did your citizen science program begin?		
How many volunteers are working with your citizen science program?		
How many researchers are working with the citizen science program?		
How many faculty members are working with your citizen science program?		
What is the majority of age/grade level of participants?		
Why was the citizen science program started?		
Who initially started the citizen science program?		
How was the citizen science program started?		
Data Collection:		
What kind of specific data do you collect?		
Why do you collect this data?		
Do you train participants in data collecting if so, who trains and how long does it last?		
How do you gather the data collected?		
How do you organize the data collected?		
What do you intend to learn from the data collected?		
What equipment is used in data collection and is it free?		
How do volunteers know what procedure to use for data collection?		

What future data collection methods have been contemplated?		
Is the data found meeting the expectations of the researchers?		
Do researchers collect data also?		
Does anyone other than the researchers use the data collected?		
Behind the Scenes:		
How to you recruit participants/volunteers?		
What's the greatest challenge that your citizen science program has ever come across?		
How to you get the funding for your citizen science program?		
Where do you see your citizen science program ten years from now?		
If you could change anything about your citizen science program what would it be?		
If you could get the funding and could only spend it on one specific thing what would it be and why?		
What makes your citizen science program different from any other citizen science program?		
What makes your citizen science program more successful than other citizen science programs?		
What makes your citizen science program less successful than other citizen science programs?		
What makes your citizen science program stronger/weaker than other citizen science programs?		
What would be your advice for someone who is trying to start a citizen science program?		
Are you going to try and expand your citizen science program?		

Appendix B: Scientist Interview

Scientist:		
Date:		
Email:		
Phone Number:		
Interviewed By:		
QUESTIONS:		**ANSWERS:**
Background:		
Where is the data you work with originated? (i.e. volunteers, museums)		
Have you worked with any data collected by citizen science programs, if so which ones?		
Do you find the data collected by citizen science programs is efficient enough for your research?		
What kind of specific data do you work with?		
What other kinds of data have you worked with in the past?		
What results have you found from the data collected?		
After you have completed research where does the data go? Who uses it?		
How many other scientists do you work with?		
How long have you been in the scientists/research field?		
How much time do you spend on each research project?		
Behind the Scenes:		
What's the greatest challenge you face as a scientist/researcher?		
If you could change anything about your research process what would it be and why?		

Appendix C: Citizen Science Database Interview

Name of Organization:		
Date:		
Email:		
Phone Number:		
Speaking to:		
Interviewed by:		
QUESTIONS:		**ANSWERS:**
Introduction:		
What is the name of the program/database your organization uses?		
How long have you had this program/database?		
How much does this program/database cost?		
By who is your program/database maintained and managed by?		
How easy is to maintain the program/database?		
What age levels can easily use this program/database?		
Why did you choose this program/database?		
Who choose to use this program/database?		
How easy is the program/database able to upgrade?		
How often do you upgrade your program/database?		
What training mechanisms or workshops are done to use these programs/databases?		
Users:		
Where is the information found originated?		
How quickly after entered can researchers access the information?		
Why do researchers need the information found and what is the result from the data collected?		
Who specifically uses the information stored in the program/database?		
Intended Use:		
What was in mind when chosen this program/database?		

What components were you specifically looking for when obtaining this program/database?		
Did you have a prototyping stage?		
System Specifics:		
What other programs/databases did you consider or have come across?		
What exactly does this program/database do for you?		
How much information does it currently store?		
What's the maximum information it can store?		
Why did you choose this program/database?		
How fast of computer do you need to run this program/database?		
Is the program/database connected to the internet?		
Does your program/database have to involve pictures, sounds, and video clips?		
Is there anything specific that your program/database needs to include in order to benefit the researchers?		
How many templates do you have for data collecting volunteers?		
How easy is it for people to share there data with other organizations?		
Personal Views:		
What do you like about the program/database?		
What don't you like about the program/database?		
If you could change one thing about the program/database what would it be?		
Would you recommend this program/database to other citizen scientist?		
Rating System:		
What do you feel is the least important components to a program/database?		
What do you feel are the most important components to a program/database?		
Maintaining, user-friendliness, cost, managing, up-datating, expanding, program/database potential		

Appendix D: Cornell Lab of Ornithology General Interview

Name of Organization:		Cornell Lab of Ornithology-Feederwatch
Date:		4.5.05
Email:		cornellbirds@cornell.edu
Phone number:		607.254.2457
Speaking to:		David Bonter
Interviewed by:		Keyla L. Arnal
QUESTIONS:		**ANSWERS:**
Background:		
When did your citizen science program begin?		Feederwatch one of the oldest citizen science programs Cornell Lab of Ornithology offers in 1987
What caused your program to get started?		Communities interest in birds
How many volunteers are currently working with your program?		25-30 volunteers/participants
What is the source of funding for your program?		National Science Foundation, $15.00 yearly membership fee, and private foundations
What is the average age and education of the participants in your program?		All school levels and senior citizens
Data Collection:		
What kind of specific data do you collect?		Birds, weather data collection, where birds are, habitat information, amphibian monitoring, butterflies
Why do you collect this data?		To see changes over time
How do volunteers know what procedure to use for data collection?		Strict Protocols an 8 page instruction booklet and graphics is provided (paper & online)
Do you train the participants for data collection? If yes, who trains them and how long does it last?		Done once several years ago and was done and finished on a weekend
What equipment is used in data collection and is it free?		Binoculars, bird boxes, bird feeders, and not free
Behind the Scenes:		
How do you recruit participants/volunteers?		Birds are a natural hook, but marketing communications promotes in the newspaper

What is the greatest challenge your program has ever come across?		Recruitment
Are you going to try and expand your citizen science program?		Yes

Appendix E: Adirondack Co-op Loon Program General Interview

Name of Organization:		Adirondack Cooperative Loon Program
Date:		4.8.05
Email:		
Phone number:		
Speaking to:		Dr. Nina Schoch
Interviewed by:		Self fill out
QUESTIONS:		**ANSWERS:**
Background:		
When did your citizen science program begin?		ACLP was initiated in 2001.
What is the majority of age/grade level of participants?		Adults but 16 if accompanied by an adult
Data Collection:		
What kind of specific data do you collect?		Environmental mercury pollution on wildlife, using loons as an example
Do you train participants in data collecting if so, who trains and how long does it last?		Trained individually through our staff and they are encouraged to attend a public presentation to understand ACLP's objectives for our work.
How do you organize the data collected?		Submitted via Excel spreadsheets, then incorporated into Access database then results posted to ACLP website, or in reports.
What do you intend to learn from the data collected?		Information about trends in the Adirondack loon population and habitat utilization.
What equipment is used in data collection and is it free?		Microsoft Office for data not free but, data forms are posted to ACLP website. Census observers need to provide postage to return forms.
What future data collection methods have been contemplated?		Always interested in learning about how such efforts are conducted by other organizations.
Behind the Scenes:		
How to you recruit participants/volunteers?		End of season party, interaction with ACLP staff, providing info in ACLP biannual newsletters and on website.

What's the greatest challenge the your citizen science program has ever come across?		Not enough staff/time to respond to information requests from the public in as timely a manner as would like b. Funding for staff salaries to coordinate ACLP's research & education efforts, prepare and distribute outreach materials, and for office and field expenses.
How to you get the funding for your citizen science program?		Grants and donations to the Wildlife Conservation Society and the Natural History Museum of the Adirondacks

Appendix F: Worm Watch General Interview

Name of Organization:		Worm Watch
Date:		4.5.05
Email:		naturewatch.ca
Phone number:		905.336.4411
Speaking to:		Elizabeth Kilvert
Interviewed by:		Sarah Doyon
QUESTIONS:		**ANSWERS:**
Background:		
When did your citizen science program begin?		Sept 2000 Frogwatch started
What caused your program to get started?		Nature watch was the initial beginning and foundation for all of the other programs started by the government
Who initially started the program? How?		Lots of pilot monitoring, each starts with mostly community programs- 100 cities across Canada. Plant watch and Frog watch USA
How many volunteers are currently working with your program?		25,000. Volunteer coordinators in every site. Each has a regional and local center. Museums are key Ontario Science Center, gives a role to them
Are there any paid staff working with your program? If yes, how many?		Coordinator of programs are paid… full time jobs, asses, marketing
What is the level of funding required for the functioning of your program?		Federal government funding. Budgeted funding, of all types. They have abilities to get $ from foundations
How many researchers are collaborating with your program?		A network of researchers, partnership with universities, and individuals
Are any of these researchers university faculty? If yes, how many?		Almost all are from the university level and federal and provincial governments.
What kind of research do these researchers carry out?		What are we seeing over the years? Producing assessments
What is the average age and education of the participants in your program?		Demographics. Worm Watch=younger children Icewatch=wide appeal, records tends to be from retired Frogwatch= wide Plantwatch=older professional

Data Collection:		
What kind of specific data do you collect?		Night crawlers because they are changing the composition of forests
Why do you collect this data?		Provide people with a hypothesis, and allow them to go out an collect
How do volunteers know what procedure to use for data collection?		Trainers from the universities
Do you train the participants for data collection? If yes, who trains them and how long does it last?		Mentor will pair up a classroom and act as resources
What equipment is used in data collection and is it free?		These programs were stared because they are not equipment intensive. They so lend kits if needed
How do you organize the data collected?		Encouraged to submit it online, or they can mail in the data sheet
What do you intend to learn from the data collected?		Provide people with a hypothesis, and allow them to go out an collect
What other future data collection methods have been contemplated?		There is a number of new programs starting to monitor flowers ect.
Does the collected data meet the expectations of the researchers?		The data is reviewed/analyzed, not necessarily expectations
Do the researchers also collect data?		Not specifically for the program
Does anyone other than the researchers use the data collected?		Everyone collects
Behind the Scenes:		
How do you recruit participants/volunteers?		Many choose to participate, the program uses flyers and marketing methods
What is the greatest challenge your program has ever come across?		Never enough time, using online systems, mapping systems.. Never satisfies everyone.
Where do you see your program ten years from now?		Expanding more and more
How do you see your program in terms of its strength and weaknesses?		Very strong and well spread
What would be your advice for someone who is trying to start a citizen science program?		Try and get the attention of the volunteers who do not have to spend money and can easily help
Are you going to try and expand your citizen science program?		It is always expanding

Appendix G: New England Household Pests General Interview

Name of Organization:		New England Household Pests (Harvard University)
Date:		4.17.05
Email:		gary_alpert@harvard.edu
Phone number:		617.495.1983
Speaking to:		Gary D. Alpert
Interviewed by:		Keyla L. Arnal
QUESTIONS:		**ANSWERS:**
Background:		
When did your citizen science program begin?		In 2002
What caused your program to get started?		Communities request of information on bugs
Who initially started the program? How?		Gary D. Alpert, through Harvard University
How many volunteers are currently working with your program?		4 volunteers
Are there any paid staff working with your program? If yes, how many?		No
What is the level of funding required for the functioning of your program?		30,000$
What is the source of funding for your program?		Environmental Protection Agency
How many researchers are collaborating with your program?		Zero
Are any of these researchers university faculty? If yes, how many?		4 staff members
What kind of research do these researchers carry out?		None
What is the average age and education of the participants in your program?		PHD level
Data Collection:		
What kind of specific data do you collect?		Information all kinds of bugs
Why do you collect this data?		Citizens wanted to know what insects surrounded the home
How do volunteers know what procedure to use for data collection?		Simply answer questions and samples from citizens

Do you train the participants for data collection? If yes, who trains them and how long does it last?		No
How do you gather the data collected?		Put on website
What equipment is used in data collection and is it free?		Server, 10 digital cameras, microscope
What other future data collection methods have been contemplated?		Better images and upgrades in the software
Does the collected data meet the expectations of the researchers?		Yes
Do the researchers also collect data?		Yes
Does anyone other than the researchers use the data collected?		Open to community
Behind the Scenes:		
How do you recruit participants/volunteers?		Volunteers have created there own motivation and enthusiasm
What is the greatest challenge your program has ever come across?		Getting it to continuously grow without a funding source
Where do you see your program ten years from now?		Be able to identify ANY kind of insect at there website
If you could change anything about your program what would it be?		Better interface for users, needs more color, fun, and user friendly
If you could get the funding and could only spend it on one specific thing what would it be and why?		The re-development of a web page
How do you see your program in terms of its strength and weaknesses?		Good science behind the images (New England)
What would be your advice for someone who is trying to start a citizen science program?		Plan a network and start small
Are you going to try and expand your citizen science program?		Eventually expand throughout the U.S.

Appendix H: Friends of Acadia General Interview

Name of Organization:		Friends of Acadia
Date:		4.7.05
Email:		stephanie@friendsofacadia.org
Phone number:		207.288.3340
Speaking to:		Stephanie Clement
Interviewed by:		Keyla L. Arnal
QUESTIONS:		**ANSWERS:**
Background:		
When did your volunteer program begin?		In 1986
What caused your program to get started?		Wanted to preserve and protect natural beauty and surroundings
How many volunteers are currently working with your program?		2,200 volunteers last year, 5-6 interns
Are there any paid staff working with your program? If yes, how many?		9 Fulltime Staff, 2 Long-term seasonal volunteers in park (Advocacy work asks congress the needs of the park service
What is the source of funding for your program?		Private funding, contributions, and grants to get equipment and paid assistance
What is the average age and education of the participants in your program?		All ages, High School, senior citizens, college students
Data Collection:		
What kind of specific data do you collect?		Hiker census, count number people on the trails (random sampling) carriage work, road work, maintenance
Why do you collect this data?		For park service they maintain the database
Do you train the participants for data collection? If yes, who trains them and how long does it last?		No, but should have 1st aid kit be CPR certified
How do you gather the data collected?		Ridge runners
What equipment is used in data collection and is it free?		Clipboard and pen
How do you recruit participants/volunteers?		Word of mouth, web, brochures at hotels/inns, park, newspaper

Appendix I: Journey North General Interview

Name of Organization:	Journey North
Date:	4.7.05
Email:	halvor@smm.org
Phone number:	617.823.0958
Speaking to:	Joel Halvorson
Interviewed by:	Keyla L. Arnal
QUESTIONS:	**ANSWERS:**
Background:	
When did your citizen science program begin?	In 1991
What caused your program to get started?	Branched off a arctic migration sub project, demonstration project for teachers
Who initially started the program? How?	Elizabeth Howard wanted to do good demonstration project for classroom
How many volunteers are currently working with your program?	Scientists and data collectors (no number)
Are there any paid staff working with your program? If yes, how many?	5 Fulltime equivalents, team 10-12 people
What is the level of funding required for the functioning of your program?	$400000 per year
What is the source of funding for your program?	Annenberg Foundation (one of largest foundations)
How many researchers are collaborating with your program?	20 researchers that are directly involved on regular basis
Are any of these researchers university faculty? If yes, how many?	Depends
What kind of research do these researchers carry out?	Habitat behavioral (i.e.: bald eagles, butterflies), environmental condition,
What is the average age and education of the participants in your program?	Students around 12 years old
Data Collection:	
What kind of specific data do you collect?	Incidents, "first", when certain plant/species emerge, phenology
Why do you collect this data?	So classrooms can do comparative analysis
How do volunteers know what procedure to use for data collection?	Volume data

Do you train the participants for data collection? If yes, who trains them and how long does it last?	Yes have been done before
How do you gather the data collected?	Pre-registered online, fill our field that goes to central database
What equipment is used in data collection and is it free?	Pen and paper
What do you intend to learn from the data collected?	How data can be used to have a visual sense
Does the collected data meet the expectations of the researchers?	Don't have expectations because project is for classrooms
Do the researchers also collect data?	YES, gets shared with kids
Does anyone other than the researchers use the data collected?	Some researchers might need it for college students and projects
Behind the Scenes:	
How do you recruit participants/volunteers?	Word of mouth
What is the greatest challenge your program has ever come across?	Getting classroom teachers to change style of instruction so that they can take full advantage of the project
Where do you see your program ten years from now?	Very vibrant and dynamic with users, more opportunities for non classroom participants, public television program
If you could change anything about your program what would it be?	Change the perception that it is a elementary level project
If you could get the funding and could only spend it on one specific thing what would it be and why?	Develop television and film programming
How do you see your program in terms of its strength and weaknesses?	Simplicity and design, multi disciplinary, can use in any academic area
What would be your advice for someone who is trying to start a citizen science program?	Can be over whelming to the uninitiated, don't try and do it all, do what fits. Start small, and avoid collecting data for nothing

Appendix J: Friends of Fresh Pond General Interview

Name of Organization:		Friends of Fresh Pond
Date:		4.30.05
Email:		Friendsoffreshpond@yahoo.com
Phone number:		617.956.2849
Speaking to:		Jean Rogers
Interviewed by:		Keyla Arnal, Sarah Doyon, Erin Ellsworth, Jason Sansoucie
QUESTIONS:		**ANSWERS:**
Background:		
When did your citizen science program begin?		2001-2002
How many volunteers are working with your citizen science program?		Park division has 122 members.
What is the majority of age/grade level of participants?		All ages.
Why was the citizen science program started?		Because people wanted a clean park where the community can exercise and get away from city.
Data Collection:		
What kind of specific data do you collect?		Animal tracks, birds, water samples, trees, plants, insects, algae, and macro-invertebrates.
Why do you collect this data?		Park doesn't know anything on ecology and they need to provide the water treatment division with information for the construction that is being done.
Do you train participants in data collecting if so, who trains and how long does it last?		Yes, in wildflowers, tree identity, and bird watching. Classes are a free two-hour session and also provide access to binoculars and field guides.
How do you organize the data collected?		All information is put into an online database, but is also accessible in paper form at the park.
What do you intend to learn from the data collected?		Water and habitat changes.
What equipment is used in data collection and is it free?		10X binoculars, diagrams, and field guides are provided by FFP.
Behind the Scenes:		

How to you recruit participants/volunteers?		Biodiversity day also have orange and green flyers along with monthly press releases, websites, and emails.
What's the greatest challenge the your citizen science program has ever come across?		Assembling groups together to get accurate sensible data and then transitioning it from data to information.
How to you get the funding for your citizen science program?		Members of FFP each have to pay a $10 membership fee that contributes to field guides and bird boxes.
If you could get the funding and could only spend it on one specific thing what would it be and why?		Creating a place where FFP can hold store and sort thousands of photos and making it accessible by anyone.
What makes your citizen science program stronger/weaker than other citizen science programs?		Big weakness is not having a database to store all the data.

Appendix K: Friends of Menotomy Rocks General Interview

Name of Organization:		Friends of Menotomy Rocks
Date:		4.30.05
Email:		jpickle@mos.org
Phone number:		617.589.0436
Speaking to:		John Pickle
Interviewed by:		Keyla L. Arnal
QUESTIONS:		**ANSWERS:**
Background:		
When did your citizen science program begin?		In 1995.
How many volunteers are working with your citizen science program?		13 volunteers
What is the majority of age/grade level of participants?		All different age groups.
Why was the citizen science program started?		All started because people cared about the park recreationally and artistically and wanted it to be inviting.
Data Collection:		
What kind of specific data do you collect?		Test water quality, greening up and greening down, bud bursts, migrations, phenology data, and birds.
Why do you collect this data?		From data collected you can see how invasive pond weed, old dying plants, and pollution effects the pond
What do you intend to learn from the data collected?		When plants change it allows a participant to see how off set the animals lives are changing, and how land cover use effects the environment. The time lapse determines climate change, air quality, and invasive species that eventually affect the trees.
What equipment is used in data collection and is it free?		Digital photography used on wood or metal picture posts. Water poly testing kits $1500.00. Not free.
Behind the Scenes:		

How to you recruit participants/volunteers?		Earth Day and Biodiversity Day are main advertisements for the Friends groups, which consist of earth appreciation activities, aimed towards younger participants
What's the greatest challenge the your citizen science program has ever come across?		The fact that training takes a lot of time and a lot of volunteers to do, has made it hard to do, but if could meeting twice a month for picture training would be ideal.
How to you get the funding for your citizen science program?		Funding is received by the members themselves and all the money goes to the infrastructure of the programs.
If you could get the funding and could only spend it on one specific thing what would it be and why?		Create a web-organized system.

Appendix L: MDI Water Quality Coalition

Name of Organization:		MDI Water Quality Coalition
Date:		4.26.05
Email:		jane@mdiwqc.org
Phone Number:		207-288-2598
Speaking to:		Jane Disney
Interviewed by:		Keyla L. Arnal
QUESTIONS:		**ANSWERS:**
Introduction:		
What is the name of the program/database your organization uses?		Access
How long have you had this program/database?		7 years
How much does this program/database cost?		Nothing beyond initial purchase of Microsoft Office
By who is your program/database maintained and managed by?		Executive Director
How easy is to maintain the program/database?		Challenged at times
What age levels can easily use this program/database?		High School Aged Students and Adults
Why did you choose this program/database?		It interfaces well with GIS and the PEARL Website and the forms are easy for students
Who choose to use this program/database?		They were advised at a state-level data workshop with Geoff Dates from the University of New Hampshire
How easy is the program/database able to upgrade?		Fairly easy, once they got the hang of working with forms in design view
How often do you upgrade your program/database?		Each monitoring season
What training mechanisms or workshops are done to use these programs/databases?		Nothing formal, peer-peer training. We are considering having a consultant work with everyone for a day
Users:		

Where is the information found originated?		The Community Environmental Health Laboratory
How quickly after entered can researchers access the information?		They enter Beaches data on the Healthy Beaches Website and e-mail Phytoplankton Data to the Department of Marine Resources the Same Day
Why do researchers need the information found and what is the result from the data collected?		The Beaches data is used to make decisions about opening and closing beaches. Phytoplankton data is a first alert system for red tide
Who specifically uses the information stored in the program/database?		The state, town managers (who receive weekly beach reports from us) teachers and students who contribute data and study it.
Intended Use:		
What was in mind when chosen this program/database?		We wanted to be able to track large sets of data from multiple sites over long periods of time
What components were you specifically looking for when obtaining this program/database?		Ease in data entry to eliminate errors
Did you have a prototyping stage?		Not really, we jumped right in.
System Specifics:		
What other programs/databases did you consider or have come across?		Excel spreadsheets, we use e-base to track membership
What exactly does this program/database do for you?		It allows us to organize our data and easily export it for use in other contexts.
How much information does it currently store?		5 years of water quality data
What's the maximum information it can store?		We set up new databases each year.
Why did you choose this program/database?		Described above
Is the program/database connected to the internet?		No
Does your program/database have to involve pictures, sounds, and video clips?		No
Personal Views:		

What don't you like about the program/database?		It has a bit of a learning curve for being able to set up and modify the data entry forms. We are still learning how to use it effectively.
Would you recommend this program/database to other citizen scientist?		I don't think we have a lot of choices out there. But I recommend it over storing data in excel.

Appendix M: MIT's Collaborative Mapping General Interview

Name of Organization:		MIT's Collaborative Mapping Initiatives
Date:		4.7.05
Email:		ddouglas@mit.edu
Phone number:		617. 253.1766
Speaking to:		Debbie Douglas
Caller:		Keyla L. Arnal
QUESTIONS:		**ANSWERS:**
Background:		
When did your citizen science program begin?		In process - not yet developed
What caused your program to get started?		Wanting to be anywhere and be able to learn cool stuff about where you are
Who initially started the program? How?		The idea came from Eric Heller in his National Heritage database
How many volunteers are currently working with your program?		None yet
Are there any paid staff working with your program? If yes, how many?		None yet
What is the level of funding required for the functioning of your program?		One year of formal meetings in order to prepare a proposal and budget
Data Collection:		
Why do you collect this data?		Historical data
Do you train the participants for data collection? If yes, who trains them and how long does it last?		No, but have workshops on technology and History
Behind the Scenes:		
What is the greatest challenge your program has ever come across?		Getting the funding
Are you going to try and expand your citizen science program?		Yes

Appendix N: Cape Cod National Seashore General Interview

Name of Organization:		Cape Cod National Seashore
Date:		4.23.05
Email:		Barbara_Dougan@nps.gov
Phone number:		508.888.1167
Speaking to:		Barbara Dougan
Interviewed by:		Keyla L. Arnal
QUESTIONS:		**ANSWERS:**
Background:		
When did your citizen science program begin?		In 1961.
What is the majority of age/grade level of participants?		Aerial Pictures consist of staff and research scientists because of insurance liabilities. Also the Fitchburg Pilot Association.
Why was the citizen science program started?		National Park Service receives all the information and uses it to see the different changes in the park also to measure vegetation growth and health. Mainly for research purposes and support for Cape Cod's habitat.
Data Collection:		
What kind of specific data do you collect?		Data collected depends on the research being done but can vary from shoreline change, on shoreline change, bars, angles, and waves.
How do you gather the data collected?		All data on hard drive and everything is posted on a server so the public can get a hold of it therefore the information is being shared on a government server.
What equipment is used in data collection and is it free?		Cameras and not free. Thumbnails software is used to store the data collected, although this is not free.
How do volunteers know what procedure to use for data collection?		Pilot and copilot go in plane and take notes on altitude, landmarks, and angles of sun, wind conditions, and changes in speed. This all helps recreate the picture. The pictures can measure distance, change, and size. Each picture is labeled with properties.

What other data collection techniques have been used?		Ground Truthing is done but requires guidelines and is done with camera and film.
Is the data found meeting the expectations of the researchers?		Yes.
Do researchers data collect also?		Yes.
Behind the Scenes:		
What's the greatest challenge the your citizen science program has ever come across?		How to use pictures, are they getting used, what gaps do we have and often do we have to fly.

Appendix O: Cape Cod National Seashore General Interview

Name of Organization:		**Cape Cod National Seashore**	
Date:		**4.26.05**	
Email:		Barbara_Dougan@nps.gov	
Phone number:		508.255.2112 ext. 23	
Speaking to:		Brett Amy Thelan	
Caller:		Keyla L Arnal	
QUESTIONS:		**ANSWERS:**	
Background:			
When did your citizen science program begin?			
How many volunteers are working with your citizen science program?			
How many researchers are working with the citizen science program?			
How many faculty members are working with your citizen science program?			
What is the majority of age/grade level of participants?			
Why was the citizen science program started?			
Who initially started the citizen science program?			
How was the citizen science program started?			
Data Collection			
What kind of specific data do you collect?		bivalve species richness and density in East Harbor.	

Why do you collect this data?		Bivalves have only recently begun to return to this restoring estuary. Collecting data on bivalve species richness and abundance will provide baseline information on bivalve populations, and enable us to detect changes in East Harbor bivalve populations over time. The return of bivalves to East Harbor is an important result of the park's estuarine restoration efforts at the site.	
Do you train participants in data collecting if so, who trains who and how long does it last?		Participants will receive approximately half a day of hands-on training from a visiting researcher (Amy)	
How do you gather the data collected?		In small groups, volunteers will locate sampling points, set up quadrats, take benthic cores, rake each quadrant with a clam rake, force benthic cores through sieves, and sieve out identify bivalves	
How do you organize the data collected?			
What do you intend to learn from the data collected?		This project should provide baseline information on bivalve species richness and density at East Harbor. If the sampling protocol is repeated every 3-5 years, it should also provide information on how bivalve populations in East Harbor change over time (and respond to additional restoration efforts).	
What equipment is used in data collection and is it free?		Clam rakes, soil sieves, GPS unit, PVC quadrats, soil corers, field guides, chest waders. No its not free	
How do volunteers know what procedure to use for data collection?		They will receive hands-on training. It will also be written out for them, and they will be supervised in the field by a visiting researcher. (Amy)	

What future data collection methods have been contemplated?			
Is the data found meeting the expectations of the researchers?		THIS is precisely what I intend to find out with my thesis project!.	
Do researchers data collect also?		Yes	
Does anyone other than the researchers use the data collected?			
Behind the Scenes			
How to you recruit participants/volunteers?		I'm still figuring this out...I'm trying to hook into local organizations that have ready volunteer bases, such as the Senior Environmental Corps and the Friends of Cape Cod National Seashore. I also plan to post flyers in local libraries, the visitor centers, etc.	
Whats the greatest challenge the your citizen science program has ever come across?		It seems a little premature to answer this, but I know there have been some issues with high volunteer turnover	
How to you get the funding for your citizen science program?			
Where do you see your citizen science program ten years from now?			
If you could change anything about your citizen science program what would it be?			
If you could get the funding and could only spend it on one specific thing what would it be and why?			
What makes your citizen science program different from any other citizen science program?			
What makes your citizen science program more successful than other citizen science programs?			

Appendix P: Scientist Interview Result

Scientist:		John Hodges
Date:		4-28-05
Email:		jcfh@bu.edu
Phone Number:		617-353-9374
Interviewed By:		Sarah Doyon
QUESTIONS:		**ANSWERS:**
Background:		
Where is the data you work with originated? (i.e. volunteers, museums)		We work with observations from the NASA EOS MODIS instruments on the TERRA and AQUA satellites, the NASA Landsat satellites, and other observations collected both by our team at Boston University and colleagues worldwide.
Have you worked with any data collected by citizen science programs, if so which ones?		We are exploring the possibilities of a collaboration with a Citizen Science program at the Boston Museum of Science, and are evaluating the data available through the NASA GLOBE K-12 student program. We have not yet used these data.
Do you find the data collected by citizen science programs is efficient enough for your research?		N/A
What kind of specific data do you work with?		We mostly work with passively collected optical satellite observations, typically in a variety of digital raster formats. First hand observation on the ground as well as from aircraft also play a part. Historical paper maps still have uniquely helpful information for us, too.
What other kinds of data have you worked with in the past?		See Above.
What results have you found from the data collected?		Information about our work is available at http://geography.bu.edu/landcover/ and http://geography.bu.edu/brdf/. Briefly,

		we are part of a large international effort to better quantify a number of global environmental variables. Our particular concerns center on land cover classification, land cover phenology, and albedo. These are some of the quantities needed for global systems science as we refine our understanding of our planet.
After you have completed research where does the data go? Who uses it?		Our data are archived by the USGS and are freely available to anyone in the world with web access at http://edcimswww.cr.usgs.gov/pub/imswelcome/. Our reports about what we've learned along the way are published in such journals as Science, Nature, the Journal of Geophysical Research, Remote Sensing of Environment, and the International Journal of Remote Sensing. It is used by scientists trying to understand global climate, aid agencies trying to allocate resources, regional public policy planners, conservation advocates, and educational groups.
How many other scientists do you work with?		
How long have you been in the scientists/research field?		
How much time do you spend on each research project?		
Additional Information:		We are a part of a very large international team of engineers and scientists working to better understand our world. We've been at it for some time, and are making some good progress. We hope to continue to learn more, and that what we learn will be helpful in informing debate about appropriate environmental public policy.

Appendix Q: Imagery Analysis CD Summary

Thank you for working with our 13 software programs and related six activities that help people learn the concepts and skills needed to interpret satellite images. The following information describes the materials on the CD and how to use the software on your Mac or PC computer.

There are **four** folders on the CD: one for documents (Word, RTF, and PDF versions of teacher and student guides and technical software manual), one for PC software, and two for Mac software (OSX and "Classic", which is OS9 and earlier). The software programs are divided into six Activity folders. See the table at the end of this document that describes the software programs.

To run the software, either double click on the icon displayed when viewing the CD folders or copy the folders onto your computer's hard disk and double click on these icons. Running the programs from the CD is slower than running from your hard disk.

Essential Computer Settings and Software

- ***Set computer monitors to a screen size of at least 1024 x 768.***

  Although several programs run on 800 x 600 resolution screens, if the screen resolution can be set to 1024 x 768, all programs will be able to run when needed. Only a portion of the computer activity will be seen using smaller screen dimensions. NOTE: there are "small" versions of many programs (but not all), which can run on computers with a screen size of 800 x 600. These are found in the subdirectories labeled "Small" in each activity folder.

- ***Set computer colors for the maximum number of possible colors.***

  You will need to have *at least several thousand colors* available for these activities to produce the required range of colors.

If using PCs, you will need to download and install **Quicktime** onto each computer. This Apple program is free at: http://www.info.apple.com/usen/quicktime/

While installing the program using the menu-driven procedure, make sure the option for viewing 'jpegs' is selected using the appropriate button.

If you have questions, please contact me at jpickle@mos.org or 617-589-0436.

Thank you,

John Pickle
Program Manager, Global Systems Science
Museum of Science
Science Park
Boston, MA 02114-1099

Software Summary Chart

Software Name	Activity Folder	Use of Software
MixingColor	1	Compare how colors mix using pigments and light
TriColor	1	Explore the colors created by mixing varying intensities of red, green, and blue light
Game_TriColor	1	Test your ability to identify the intensities of the red, green, and blue components of a color on the computer screen. Colors are created by playing another person or against the computer.
Report_TriColor	1	A report on how well students identify the intensities or red, green, and blue for 10 random colors is generated on-screen, in a text file, and printed for teacher or student use.
PixelView	2	Change the size of pixels for any digital picture (jpeg, gif, tiff, or pict)—called *pixelation*
ColorPicture	2	Separate the red, green, and blue color components of any digital picture (jpeg, gif, tiff, or pict)
SplitColors	2	*Advanced* manipulation of the red, green, and blue color components of any digital picture (jpeg, gif, tiff, or pict)
ImageAnalysis	2 and 6	Using *advanced* tools, analyze the spatial/color info within digital images (jpeg, gif, tiff, or pict)
MergePictures	2	Combine time-lapse pictures onto one image
FalseColor	4	Similar to ColorPicture, manipulate the color display components of a Landsat image
SurfaceType	5	Using *simplified* tools, analyze the spatial and spectral information within a standard color composite Landsat image
VegetationAnalysis	6	Using *advanced* tools, study the spatial and spectral information within a time-series of Landsat images
LandSatAnalysis	6	Using *advanced* tools, analyze the spatial and spectral information within a standard color composite Landsat image

Appendix R: Nature Mapping Program Database Interview

Name of Organization:		The Nature Mapping Program
Date:		04.05.05
Email:		vicon@u.washington.edu
Phone Number:		206.616.2031
Speaking to:		Karen M. Dvornich
Interviewed by:		Keyla L. Arnal
QUESTIONS:		**ANSWERS:**
Introduction:		
What is the name of the system?		University of Washington
How long have you had it?		11 years ago in 1994
How much does it cost?		Free
How is it maintained?		Server maintained by the University of Washington
How easy is it to learn to use?		Very easy to use
How easy is it to learn to maintain?		Volunteers learn very easily
How easy is it to upgrade?		
What training mechanisms for all of the above are available?		Volunteers are weekly individually trained to use equipment and GIS
Intended Use:		
What was your initial mission for this particular system?		Make it interactive, where people can ask questions and get it answers back graphically
What components were you specifically looking for when obtaining the system?		Growth and server because a lot of people at once hit the server 34,000 people per week
Did you have a prototyping stage?		Experimenting trial and error with the public (how long to make another state and pages to match and be similar)
System Specifics:		
What other systems did you consider? Why this system?		Data systems gave up because updates were to expensive therefore switched to the web
What exactly does it do for you?		Answers people's questions, offered materials for teachers, detailed maps, and range maps
How much information does it currently store?		Terabytes a lot

Can you give an example of about how much data this database can store?		640 species in Washington State, when participants put data in they can also make a little website, 261 pages per subject (wildlife, water)
Who has access to it?		Anyone can access no password or login necessary
Is it connected to the internet?		Yes
Is it user-friendly?		Very user friendly
Who manages it?		Karen her self manages it
How often is it updated?		Updated every 6 months (Maps)
Do you have a template for data components?		17 variables and 16 variables in the wildlife spreadsheets
Personal Views:		
What do you like about the system?		The simplicity and the fact that a third grader vs. a professional can use it
What don't you like about the system?		That it doesn't have an interactive feedback activated
Rating System:		
What do you feel are the most important components to a system?		
Maintainability, user-friendly, cost, manageability, up-datability, expansibility, system potential		User friendly
Extra:		
		Running a grant to allow faster updates, like monthly updates (Maps) also wants to do fish and insects,
		The maps now are fast but cant do anything with them (jpeg not zooming in just another picture)
		The database is more effort to maintain: Errors are hard (5) but once written its fine, its programmed by professionals
		Program started in 1992 active in 1993 web in 1994

Appendix S: Worm Watch Database Interview

Name of Organization:		Worm Watch
Date:		4.5.05
Email:		Naturewatch.ca
Phone Number:		905.336.4411
Speaking to:		Elizabeth
Interviewed by:		Sarah Doyon
QUESTIONS:		**ANSWERS:**
Introduction:		
What is the name of the program/database your organization uses?		Oracle Database, moving towards an open GIS system, publish data to mapping sources, want the data freely available
How long have you had this program/database?		Since 2000- developed database… no problem sharing it
How much does this program/database cost?		Expensive $10,000 licensing fee, open sources GIS has no fee
By who is your program/database maintained and managed by?		Data IT person, server where it resides, constantly updated,
How easy is to maintain the program/database?		IT person is paid to maintain
What age levels can easily use this program/database?		Any, very simple format.
Why did you choose this program/database?		It was the largest, with the most opportunity for expanding
How easy is the program/database able to upgrade?		Easy.
How often do you upgrade your program/database?		Constantly
What training mechanisms or workshops are done to use these programs/databases?		Simple entry format. There is a 3 stage process= name, latitude and longitude then enter information
Users:		
Where is the information found originated?		From volunteers all over who are willing to collect?
How quickly after entered can researchers access the information?		Immediately, all information can be accessed at any point
Why do researchers need the information found and what is the result from the data collected?		It can help to learn more about patterns and health within our environment

Who specifically uses the information stored in the program/database?		Everyone uses it, students, teachers, and researchers
Intended Use:		
What was in mind when chosen this program/database?		Needed something to hold all data, pictures, GIS
Did you have a prototyping stage?		The program was developed in 2000 when the organization was started, designed and developed by the organization itself
System Specifics:		
What other programs/databases did you consider or have come across?		Open GIS
What exactly does this program/database do for you?		Stores all information, allows volunteers to enter the information they have gathered
How much information does it currently store?		Unknown exact amount, enormous amounts of data.
What's the maximum information it can store?		At the moment- stores enormous amounts
How fast of computer do you need to run this program/database?		Any computer can be used, it has to be accessible for all systems
Is the program/database connected to the internet?		Yes
Does your program/database have to involve pictures, sounds, and video clips?		Pictures
Is there anything specific that your program/database needs to include in order to benefit researchers?		The information can be taken off the database to be analyzed
How many templates do you have for data collecting volunteers?		Online template
Personal Views:		
What do you like about the program/database?		Holds a lot of information, it is constantly updated
What don't you like about the program/database?		Expensive
If you could change one thing about the program/database what would it be?		Cost of license
Would you recommend this program/database to other citizen scientist?		Recommend, Open GIS
Rating System:		
What do you feel is the least important components to a program/database?		Everything is very important
What do you feel are the most important components to a program/database?		All. Metadata

Maintaining, user-friendliness, cost, managing, up-datating, expanding, program/database potential		User needs consultation, all.

Appendix T: Feederwatch Database Interview

Name of Organization:		Cornell Lab of Ornithology-Feederwatch
Date:		4.6.05
Email:		cornellbirds@cornell.edu
Phone Number:		607.254.2457
Speaking to:		David Bonter
Interviewed by:		Keyla L Arnal
QUESTIONS:		**ANSWERS:**
Introduction:		
What is the name of the program/database your organization uses?		Oracle database
How long have you had this program/database?		Since 1999 - 6 years
By who is your program/database maintained and managed by?		Full time data base manager and very hard to maintain college educated
What age levels can easily use this program/database?		All age levels can use system and its very easy to use
Why did you choose this program/database?		Not many options for large data base storages
Who choose to use this program/database?		Computer Scientist
How often do you upgrade your program/database?		No specifics but constantly with new events or programs
Intended Use:		
What was in mind when chosen this program/database?		To have the capacity to do what it had to do and still be cost effective
Did you have a prototyping stage?		No
System Specifics:		
How much information does it currently store?		Approximately 5 million pieces of information per year
Is the program/database connected to the internet?		Yes
Personal Views:		
What do you like about the program/database?		Stores the data to questions that need to be answered
What don't you like about the program/database?		Nothing

Appendix U: MIT's Collaborative Mapping Database Interview

Name of Organization:		MIT's Collaborative Mapping Initiatives
Date:		4.7.05
Email:		ddouglas@mit.edu
Phone Number:		617. 253.1766
Speaking to:		Debbie Douglas
Interviewed by:		Keyla L Arnal
QUESTIONS:		**ANSWERS:**
Introduction:		
What is the name of the program/database your organization uses?		Filemaker Pro or Oracle
Intended Use:		
What was in mind when this program/database was chosen?		Invent a free way to categorize content information
Did you have a prototyping stage?		Preparation: one year of formal meetings to prepare proposal and budget
Rating System:		
What is the most important aspect of a program/database?		System Potential, user friendly, and expansion, content and technology

Appendix V: Journey North Database Interview

Name of Organization:		Journey North
Date:		4.7.05
Email:		halvor@smm.org
Phone Number:		612.823.0958
Speaking to:		Joel Halvorson
Interviewed by:		Keyla L Arnal
QUESTIONS:		**ANSWERS:**
Introduction:		
What computer system are you using? What is its operating system?		Mac/PC OS 10/Windows XP
What is the cost of your current computer system?		Around $1500 dollars
Who maintains your computer system?		Staff
What is the name of the program/database your organization uses?		MySQL, Unix based database software
How long have you had this program/database?		About 6 years
Who choose this program/database? Why?		Anneburg technical assistants did because it ran on there system and were familiar with it
Who maintains/manages your program/database? Is it easy?		Systems operator (software, hardware), project staff (quality controlled data)
Users:		
Does your program/database store pictures, sounds, and video clips?		Yes, stores but not required
Intended Use:		
What features were you specifically looking for when obtaining this program/database?		Web interfaces, password protective, users put in data, look up latitude and longitude
Did you have a prototyping stage?		Yes
System Specifics:		
How much information does it currently store?		12 years worth of data
Personal Views:		
What do you like about the program/database you are using?		Does what it has to do
What you do not like about the program/database you are using?		Had to build web interface and had to do a lot of programming to get it to do what it needed to do
Would you recommend this program/database to other citizen scientist?		Not unless you have a full time programmer

Rating System:		
What is the most important aspect of a program/database?		Interface with a web component

Appendix W: Adirondack Co-op Loon Program Database Interview

Name of Organization:		Adirondack Cooperative Loon Program
Date:		4.8.05
Speaking to:		Dr. Nina Schoch
Interviewed by:		Self fill out
QUESTIONS:		**ANSWERS:**
Introduction:		
What is the name of the system?		Microsoft Access
How long have you had it?		Since 2001
How much does it cost?		Came with MS Office
How is it maintained?		Updates from Microsoft website
How easy is it to learn to use?		Requires training or reading the manuals
How easy is it to learn to maintain?		Requires training or reading the manuals
How easy is it to upgrade?		Updates from Microsoft website or buy new version of MS Office
What training mechanisms for all of the above are available?		Courses through local colleges, info available on websites, manuals
Intended Use:		
What was your initial mission for this particular system?		Ability to organize data in database format
What components were you specifically looking for when obtaining the system?		Ability to organize data in database format so could manage large quantities of data easily and use info in a variety of ways.
Did you have a prototyping stage?		No, but database has been revised as needed.
System Specifics:		
What other systems did you consider? Why this system?		None. Chose MS Access because readily available and can transfer data between programs without too much effort.
What exactly does it do for you?		Enables us to enter data easily, and analyzes it as data is entered.
How much information does it currently store?		100 MB
What is the capacity of the system?		I don't remember.
Who has access to it?		ACLP related personnel
Is it connected to the internet?		No
Is it user-friendly?		Yes

Who manages it?		Nina Schoch
How often is it updated?		Periodically throughout the year. Once annually with Annual Loon Census data
Do you have a template for data components?		Not quite sure what you mean here, but forms have been made to facilitate data entry.
Personal Views:		
What do you like about the system?		Can change it as needed to adapt to new components of our work.
What don't you like about the system?		My skill level is higher than most users of Access, so it's hard to find someone who can help me out if I don't know how to do something.
Rating System:		
What do you feel are the most important components to a system?		All that you listed are important things to consider when deciding on a database.

Appendix X: MDI Water Coalition Database Interview

Name of Organization:		MDI Water Quality Coalition
Date:		4.26.05
Email:		jane@mdiwqc.org
Phone Number:		207-288-2598
Speaking to:		Jane Disney
Interviewed by:		Keyla L. Arnal
QUESTIONS:		**ANSWERS:**
Introduction:		
What is the name of the program/database your organization uses?		Access
How long have you had this program/database?		7 years
How much does this program/database cost?		Nothing beyond initial purchase of Microsoft Office
By who is your program/database maintained and managed by?		Executive Director
How easy is to maintain the program/database?		Challenged at times
What age levels can easily use this program/database?		High School Aged Students and Adults
Why did you choose this program/database?		It interfaces well with GIS and the PEARL Website and the forms are easy for students
Who choose to use this program/database?		They were advised at a state-level data workshop with Geoff Dates from the University of New Hampshire
How easy is the program/database able to upgrade?		Fairly easy, once they got the hang of working with forms in design view
How often do you upgrade your program/database?		Each monitoring season
What training mechanisms or workshops are done to use these programs/databases?		Nothing formal, peer-peer training. We are considering having a consultant work with everyone for a day
Users:		

Where is the information found originated?		The Community Environmental Health Laboratory
How quickly after entered can researchers access the information?		They enter Beaches data on the Healthy Beaches Website and e-mail Phytoplankton Data to the Department of Marine Resources the Same Day
Why do researchers need the information found and what is the result from the data collected?		The Beaches data is used to make decisions about opening and closing beaches. Phytoplankton data is a first alert system for red tide
Who specifically uses the information stored in the program/database?		The state, town managers (who receive weekly beach reports from us) teachers and students who contribute data and study it.
Intended Use:		
What was in mind when chosen this program/database?		We wanted to be able to track large sets of data from multiple sites over long periods of time
What components were you specifically looking for when obtaining this program/database?		Ease in data entry to eliminate errors
Did you have a prototyping stage?		Not really, we jumped right in.
System Specifics:		
What other programs/databases did you consider or have come across?		Excel spreadsheets, we use e-base to track membership
What exactly does this program/database do for you?		It allows us to organize our data and easily export it for use in other contexts.
How much information does it currently store?		5 years of water quality data
What's the maximum information it can store?		We set up new databases each year.
Why did you choose this program/database?		Described above
Is the program/database connected to the internet?		No
Does your program/database have to involve pictures, sounds, and video clips?		No
Personal Views:		

What don't you like about the program/database?		It has a bit of a learning curve for being able to set up and modify the data entry forms. We are still learning how to use it effectively.
Would you recommend this program/database to other citizen scientist?		I don't think we have a lot of choices out there. But I recommend it over storing data in excel.

Appendix Y: New England Household Pests Database Interview

Name of Organization:		New England Household Pests (Harvard University)
Date:		4.7.05
Email:		gary_alpert@harvard.edu
Phone Number:		617.495.1983
Speaking to:		Gary D. Alpert
Interviewed by:		Keyla L Arnal
QUESTIONS:		**ANSWERS:**
Introduction:		
What computer system are you using? What is its operating system?		Windows XP, PC
What is the cost of your current computer system?		Approximately 3,000 dollars
Who maintains your computer system?		A technical assistant
What is the name of the program/database your organization uses?		Filemaker
How long have you had this program/database?		Almost 10 years
How much does this program/database cost?		Approximately 4,000 dollars
Who choose this program/database? Why?		Gary D Alpert, handles images very well
Who maintains/manages your program/database? Is it easy?		Gary D. Alpert, Piotr Naskrecki, Stefan Cover, Sara Ashworth, Brad Mitchell, Brian Farrell, Barry Sello, John Mathews, and Peter MacIntire
How often do you upgrade your program/database? Is the process easy?		Every 2-3 years
Are there training programs for the use of these programs/databases?		No
Users:		
What is the source of data for your program/database?		To store large amounts of data
Does your program/database store pictures, sounds, and video clips?		Text and pictures
How many templates do you have for data collection volunteers?		None
How quickly can researchers access the stored data/information?		Right away
What do researchers do with data in your program/database?		Look at what they have then go to website and compare it

Who specifically uses the information stored in the program/database?		Citizens and the general population
Is the program/database accessible through internet?		Yes
Intended Use:		
What was in mind when this program/database was chosen?		Easy for us to use, very fast, powerful
What features were you specifically looking for when obtaining this program/database?		Be able to handle images
Did you have a prototyping stage?		Yes
System Specifics:		
What other programs/databases did you consider or have come across?		Access
What exactly does this program/database do for you?		Store information on almost every kind of Insect
How much information does it currently store?		1,000 insect pictures
What are the requirements for the computer, which will run this program/database?		Standard PC, Windows 98
Personal Views:		
What do you like about the program/database you are using?		Its fast when pulling up images
What you do not like about the program/database you are using?		When you have a lot more data it will start to slow down
If you could change one thing about the program/database what would it be?		Nothing
Would you recommend this program/database to other citizen scientist?		Yes
Rating System:		
What is the least important aspect of a program/database?		Expanding
What is the most important aspect of a program/database?		User Friendly
Maintaining, user-friendliness, cost, managing, updating, expanding, program/database potential		

Appendix Z: Fabio Carrera Database Interview

Interview with Fabio Carrera
April 8, 2005

Note These notes were typed up subsequent to the interview with Dr. Fabio Carrera are do not necessarily include everything.

- WPI has servers that can be used for storage
- Server would contain an open source database system
    - Maintenance?
        - 1-2 Grad students could work on maintaining the system
    - Funding?
        - Could apply for a scientific/educational grant
    - Cost?
        - Should be free to Citizen Science Programs because they are the ones collecting and providing educational data
- The internet is the way of tomorrow, and things are starting to become internet based
    - All databases will eventually have an internet interface
    - Be contained and maintained on a server
- Ultimately this will make it easy for any Citizen Science Program to have a database

Appendix AA: Friends of Acadia Database Interview

Name of Organization:		Friends of Acadia
Date:		4.7.05
Email:		mikestaggs@friendsofacadia.org
Phone Number:		
Speaking to:		Mike Staggs
Interviewed by:		Keyla L Arnal
QUESTIONS:		**ANSWERS:**
Introduction:		
What computer system are you using? What is its operating system?		PC, Microsoft Office Suite 97'
What is the name of the program/database your organization uses?		Dreamweaver MX 2004
How long have you had this program/database?		5-6 years
Who choose this program/database? Why?		Mike Stagg, because can design, easy to use, and popular
Who maintains/manages your program/database? Is it easy?		Mike Stagg
Are there training programs for the use of these programs/databases?		No experience
Users:		
What is the source of data for your program/database?		Website posts for projects and development things or suggestions
Does your program/database store pictures, sounds, and video clips?		Pictures and web pages
What is the format for the entry of the collected data?		Web designer and Microsoft office have the tools to change web pages

Appendix BB: Self Evaluation Form

Please answer with the most appropriate color based on the scale below.	
= Completely fulfilled	
= Partially fulfilled	
= Not fulfilled	
Building Interest	**Answer**
Do you have the resources/personnel for the following?	
Make posters/flyers to advertise	
Disperse posters/flyers	
Write articles for the newspaper	
Speak at meetings	
Send group emails	
Track meeting "minutes"	
Accessible information on the internet	
Person willing to update information on the internet	
Person willing to respond to questions via email	
Person willing to respond to questions via phone	
Do you have funding for activities	
Do you have a proposal to gain funding for future activities	
Training	
Do you have the resources/personnel for the following?	
People with knowledge about the data being collected	
Willing people to train others to collect the data needed for your program	
The supplies needed for training	
A facility to train others	
Support	
Do you have the resources/personnel for the following?	
Do you have a system to store your data	
Do you have someone to maintain and update this system	
Can the information collected be viewed through the internet	
Do you have people who analyze the data collected	
Can the data collected be viewed by others	
Do have a way to share the data collected	
Do you have someone to manage the organization	
Do you have someone to oversee the organization	

Appendix CC: Guidelines for Citizen Science

Guidelines for Citizen Science

The following is a compilation of guidelines provided to less developed and/or newly forming Citizen Science programs that detail the steps to starting, expanding, and maintaining a Citizen Science program. These guidelines have been broken down into six chapters for programs to easily access the particular information they are seeking:

1) Self-evaluation and Assessment
2) Marketing and Advertisement Techniques
3) List of Programs, Information, and Activities
4) Innovative Data Collection and Analysis Methods
5) Interactive Decision Tree (CD)
6) Individual Database Specifications

1) Self-evaluation and Assessment

We have included a self-evaluating questionnaire to provide Citizen Science programs with a better understanding of the strengths and weaknesses of their programs. Based on the results, each program should have an idea of what qualities of their program need to be improved, and what direction their program is heading in.

Please answer the questions below based solely on the makeup of your organization. Use the color scale below to realistically determine the appropriate answer for your program.

Please answer with the most appropriate color based on the scale below.	
= Completely fulfilled	
= Partially fulfilled	
= Not fulfilled	
Building Interest	**Answer**
Do you have the resources/personnel for the following?	
Make posters/flyers to advertise?	
Disperse posters/flyers?	
Write articles for the newspaper?	
Speak at meetings?	
Send group emails?	
Track meeting "minutes"?	
Accessible information on the internet?	
Person willing to update information on the internet?	
Person willing to respond to questions via email?	
Person willing to respond to questions via phone?	
Do you have funding for activities?	
Do you have a proposal to gain funding for future activities?	
Training	
Do you have the resources/personnel for the following?	
People with knowledge about the data being collected?	
Willing people to train others to collect the data needed for your program?	
The supplies needed for training?	
A facility to train others?	
Support	
Do you have the resources/personnel for the following?	
Do you have a system to store your data?	
Do you have someone to maintain and update this system?	
Can the information collected be viewed through the internet?	
Do you have people who analyze the data collected?	
Can the data collected be viewed by others?	
Do have a way to share the data collected?	
Do you have someone to manage the organization?	
Do you have someone to oversee the organization?	

The recommendation produced will be based on the number of green, yellow or red markings the organization has evaluated itself with:

All green: You're on track! You have met the essential requirements needed for the foundation of a Citizen Science program. Please move on to step two below.

Mostly green with occasional yellow and red: Your program is very close to meeting the necessary components for a strong foundation for a Citizen Science program. The areas in red need immediate attention to continue, and the areas in yellow will be cause for struggle. Before moving on to the second step, we recommend you first fulfill these gaps in yellow and red. At the time the gaps are filled, re-evaluate using the questionnaire and find out your new assessment recommendation.

All yellow: The yellow areas can be defined as places of weakness, without each of these components in place your program will struggle. Once you feel that you have enhanced these areas, re-evaluate your program using the questionnaire and find out your new assessment recommendation.

Mostly yellow with occasional green and red: Your program is missing many essential keys in its foundation. These are necessary in moving forward, and it is recommended that each of these components be fulfilled before moving forward. Once you feel that you have repaired and enhanced these areas, re-evaluate your program using the questionnaire and find out your new assessment recommendation.

All red: Your program is missing all essential keys to its foundation. These are necessary in moving forward, and it is recommended that each of these components be fulfilled before moving forward. Once you feel that you have enhanced these areas, re-evaluate your program using the questionnaire and find out your new assessment recommendation.

Mostly red with occasional green and yellow: Your program is missing nearly all essential keys to its foundation. These are necessary in moving forward, and it is recommended that each of the red and yellow components be fulfilled before moving forward. Once you feel that you have enhanced these areas, re-evaluate your program using the questionnaire and find out your new assessment recommendation.

Mixture of greed, yellow and red: Your program is not balanced and is missing many essential keys to its foundation. These are necessary in moving forward, and it is recommended that each of the red and yellow components be fulfilled before moving forward. Once you feel that you have enhanced these areas, re-evaluate your program using the questionnaire and find out your new assessment recommendation.

2) Marketing and Advertisement Techniques

We have provided a list of marketing and advertisement techniques currently used by a majority of the mature and advanced Citizen Science programs. Next to each technique is a description of how it can be best applied.

- **Email Alias** – a compilation of volunteers' contact information who have visited or participated in your program
- **Program Website** – a website dedicated to your program that gives interested volunteers an opportunity to see what your organization is about, as well as when and where events or activities are taking place
- **Newspaper Advertisement** – post announcements in your local newspapers promoting upcoming events or volunteer days
- **School Newsletters** – provide information on upcoming activities and events at your program to local schools, and ask teachers to mention the details in the classrooms
- **Flyering** – publicize upcoming events with posters or flyers at local schools, libraries, etc.
- **Earth Day/Biodiversity Days** – utilize Earth Day and Biodiversity Days as specific volunteer events where large amounts of participants engage in numerous environmental activities

- For more information on Earth Day, and activities that you can become involved with, please visit the Earth Day Network.
- For more information on Biodiversity Day, and activities that you can become involved with, please visit Massachusetts' Executive Office of Environmental Affairs.

3) List of Programs, Information, and Activities

We have also included an index of current Citizen Science programs along with some essential information they can offer to less developed programs. Below are two charts: (1) a data type chart that displays the program, what type of data it collects, and why they collect it (2) shows a list of programs along with activities they use to collect their data.

(1) Data type Chart

Citizen Science Programs:	Type of Data Collected:	Why Is Data Collected:
Cornell Lab of Ornithology-Feederwatch	Birds, weather data collection, where birds are, habitat information, amphibian monitoring, and butterflies	See changes in environment and habitat
Adirondack Co-op Loon Program	Environmental mercury pollution on wildlife	To see the results of pollution on the wildlife
Worm Watch	Worms	To see the changing composition of forests and give people the opportunity to go out and collect data
New England Household Pests	Data on all New England insects	New England communities want information on insects that invade the home
Friends of Acadia	Hiker census and the number of people on trails	For park service
Journey North	Phenology, plants, and species	For classrooms to do comparative analysis
Friends of Fresh Pond	Animal tracks, birds, water samples, trees, plants, insects, algae, and macro-invertebrates	Park needs more information on ecology and need to provide the water department with information for the construction that is being done
Friends of Menotomy Rocks	Test water quality, greening up/down, bud bursts, migrations, phenology data, and birds	To see how invasive pond weed is with old dying plants and to the effects of pollution on the pond
MIT's Collaborative Initiatives	History of MIT and the land in which it sits in. Can consist of short video clips, songs, and pictures.	To create a compacted “on the go” historical GPS system
Cape Cod National Seashore	Shoreline change, on shoreline change, bars, angles, and waves	To give the National Park System more information on what is happening with in and around the park

(2) Citizen Science Activities

Citizen Science Program:		Activities/Programs Used:		What is gained from activities:
Cornell Lab of Ornithology		Bird counting		How winter's cold influence bird populations and will late winter movements of many songbirds and waterfowl species be as far they were last year
Wormwatch		Modified Flip and Strip		To understand more about earthworms habitats
		Modified Hand Sorting		To understand more about earthworms habitats
Icewatch		Firsthand observation		To learn how climate change is affecting our environment.
Frogwatch		Firsthand observation		Monitoring frog and toad populations is one way to check the health of wetland areas
Plantwatch		Firsthand observation		Help researchers discover how common plants are responding to climate change - and track where changes are taking place in Canada, and at what rate.
Adirondack Co-op Loon Program		Loon Migration and Banding		To acquire a broader understanding of the ecological links between loon breeding, migratory, and wintering areas and and how conservation concerns in one area have the potential to affect wildlife species, such as the loon, throughout their entire range
New England Household Pests		Research		Gain knowledge on insects
Journey North		Migrations		Predict animals arrivals and map there progress across the hemisphere.
Friends of Fresh Pond		Inventories		Helps add to the State of Massachusetts biodiversity data collection
Friends of Menotomy Rocks		Testing water quality		To help maintain a pH level that is healthy for fish and other wildlife
Cape Cod National Seashore		Shoreline measurements		To see the changes and affects of climate on the ocean

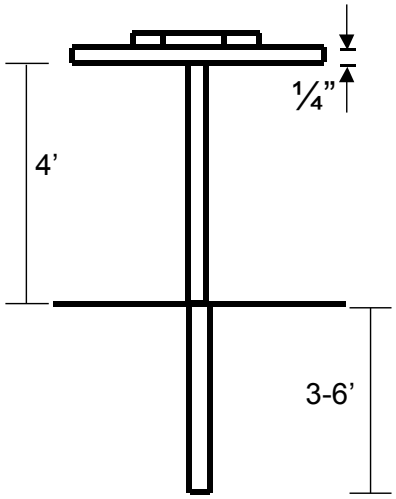
4) Innovative Data Collection and Analysis Methods

In order for Citizen Science programs to realize and utilize new and innovative methods of data collection and analysis, we have compiled a list of six techniques, each with a description and specifications:

- **Picture Post Photography**

  - A well-placed picture post can provide years of quality images that can be analyzed by scientists to gain a better understanding of our environment. The idea is to place a digital camera centered flush against one side of the octagon plate. If this is accurately done for all eight sides, then a complete 360˚ image can be created by simply taping the photos together in proper order.

  - The construction of the picture post is quite simple. A four-foot wooden or metal post is cemented three to six feet below the finished grade to protect from frost heave during the winter. From there, a quarter-inch thick circular disk with a diameter between eight to ten inches is fastened to the post. Placed in the middle of the disk is a quarter-inch thick octagonal backstop that is approximately five inches from side to side. The material used is a major issue that each organization needs to address based on funding, interest in the project, and length of time that the post will be in use. Different techniques will be necessary to fasten the disk to a wooden post versus to a metal post. For a wooden post, wood screws are sufficient to get the job done. However, for a metal post, either welding or sheet metal screws may be used. Welding would be more permanent and secure, but would also cost substantially more. On the other hand, fastening the plate to the post with screws would be much cheaper, but would be inviting to vandalism in a public park. In addition, metal posts would cost up to $500 per post, whereas wooden posts will cost significantly less, approximately $50.



- **Time-Lapse Film**

  - Time-lapse films provide programs with a unique and alternative perspective on our surroundings. By setting up a digital camera in a secure spot for an extended period of time and setting it to take pictures at a preferred time interval, many observations can be studied that would otherwise go undetected through regular daily monitoring. Observations such as vegetation growth, animal interactions, cloud cover, climate change, shadowing, and seasonal changes can be made.

- **Filtered Lenses**

  - By recognizing reflection of infrared light through a filtered lens, we can identify early signs of stress detection in plants from disease, drought, flooding, air quality, pests, and/or wintering. Having the ability to examine environmental concerns that are not apparent to the human eye will prove to be significant in the progression of our knowledge of science and our environment.

  - There are many different types of infrared lenses available to purchase. Since the majority of images that will be taken for environmental purposes will be under sunlight, it is suggested that a 1000 nm filter is used. It is imperative to know the diameter of the lens on the camera in order to purchase the correct corresponding filter (this diameter will be labeled somewhere around the front of the lens). We found that the majority of infrared lenses were selling between $50-$75. In addition, these filtered lenses may be applied to both picture post photography and time-lapse films, providing even more advancements for science, technology, and our environment.

- **CyberTracker**

  - CyberTracker Software provides "the most efficient method of field data collection, even by non-literate users, at a level of detail not possible before." With CyberTracker Software, scientists and other field workers can generate their own data entry template, or screen sequence, and use it on a handheld computer (Windows Mobile PocketPC or PalmOS) with GPS capabilities to gather and map an unlimited amount of data.

  - The actual CyberTracker Software itself can be downloaded from the Internet free of charge; however, commercial users who find this software useful are encouraged to donate money to the *CyberTracker Conservation*, a non-profit organization responsible for implementing field projects and promoting a worldwide environmental monitoring network. Therefore, the major components one must have to fully utilize the system are a personal computer, a handheld computer, and a Global Positioning System receiver. CyberTracker is installed onto the personal computer and then uploaded to a handheld computer. Using a GPS, one can geo-reference and map the collected data. After collecting the data onto the handheld computer, the information can be exported to a database system such as Microsoft Access on a personal computer. The handheld computer, which can either be a Windows PocketPC or a PalmOS, usually cost between $250-$450. The Global Positioning System, which is optional, runs around $300.

- **Digital Imagery Analysis Software**

  - See CD Attached

5) Interactive Decision Tree

The decision tree is an interactive computer-based program designed in Microsoft PowerPoint. The specific qualities that make up the tree are layered into 5 or 6 tiers, depending on the programs storage preference. The setup of the questions within the program is as follows:

- Storage type
- Picture capacity (if necessary)
- System Requirements
- Cost
- Ranking program preferences
- Database Recommendations

(See CD Attached)

6) Individual Database Specifications

After completing the computer-based interactive decision tree (above), each program will be recommended one or more databases to use in their program. Below are cost and specifications for each database, as well as which current Citizen Science program use it.

Database	Used By	Cost	Storage	System Requirements
GIS	Nature Mapping Program	_	Images	Macintosh/Windows
Oracle	Worm Watch	$10,000 (License Fee)	All	Macintosh/Windows
MYSQL	Journey North	$599/year	Images/Text	Windows
Microsoft Access	Adirondack Cooperative Loon Program	$229 – included in Microsoft XP	All – maximum of 100 images	Windows
FileMaker Pro 7.0	New England Household Pests	$300	All	Windows, Pentium 300 MHz, 64 MB RAM for Windows 2000, 128 MB of RAM for Windows XP, or Macintosh Apple G3 or higher
Open GIS	_	Free	Mapping	Macintosh/Windows
Ascii	_	Free	Text	Macintosh/Windows
Map Info Professional v.7.8	_	$1500	Mapping and Analysis	SP4, Windows NT
ArcGIS	_	Free	Mapping	PC-2000 Windows, or XP
Alternate Server	_	Free w/ permission (WPI)	All	Macintosh/Windows

Appendix DD: Advertising and Marketing Techniques

Advertising and Marketing Techniques

- **Email Alias** – a compilation of volunteers' contact information who have visited or participated in your program
- **Program Website** – a website dedicated to your program that gives interested volunteers an opportunity to see what your organization is about, as well as when and where events or activities are taking place
- **Newspaper Advertisement** – post announcements in your local newspapers promoting upcoming events or volunteer days
- **School Newsletters** – provide information on upcoming activities and events at your program to local schools, and ask teachers to mention the details in the classrooms
- **Flyering** – publicize upcoming events with posters or flyers at local schools, libraries, etc.
- **Earth Day/Biodiversity Days** – utilize Earth Day and Biodiversity Dys as specific volunteer events where large amounts of participants engage in numerous environmental activities

- For more information on Earth Day, and activities that you can become involved with, please visit the Earth Day Network.
- For more information on Biodiversity Day, and activities that you can become involved with, please visit Massachusetts' Executive Office of Environmental Affairs.

Appendix EE: Citizen Science Data Type Chart

Citizen Science Programs:	Type of Data Collected:	Why Is Data Collected:
Cornell Lab of Ornithology-Feederwatch	Birds, weather data collection, where birds are, habitat information, amphibian monitoring, and butterflies	See changes in environment and habitat
Adirondack Co-op Loon Program	Environmental mercury pollution on wildlife	To see the results of pollution on the wildlife
Worm Watch	Worms	To see the changing composition of forests and give people the opportunity to go out and collect data
New England Household Pests	Data on all New England insects	New England communities want information on insects that invade the home
Friends of Acadia	Hiker census and the number of people on trails	For park service
Journey North	Phenology, plants, and species	For classrooms to do comparative analysis
Friends of Fresh Pond	Animal tracks, birds, water samples, trees, plants, insects, algae, and macro-invertebrates	Park needs more information on ecology and need to provide the water department with information for the construction that is being done
Friends of Menotomy Rocks	Test water quality, greening up/down, bud bursts, migrations, phenology data, and birds	To see how invasive pond weed is with old dying plants and to the effects of pollution on the pond
MIT's Collaborative Initiatives	History of MIT and the land in which it sits in. Can consist of short video clips, songs, and pictures.	To create a compacted “on the go” historical GPS system
Cape Cod National Seashore	Shoreline change, on shoreline change, bars, angles, and waves	To give the National Park System more information on what is happening with in and around the park

Appendix FF: List of Citizen Science Activities

Citizen Science Program:		Activities/Programs Used:		What is gained from activities:
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Wormwatch		Modified Flip and Strip		To understand more about earthworms habitats
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