



Increasing Participation of Citizen Scientists in the Digital Earth Watch Project

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Abstract

The Digital Earth Watch (DEW) project is a NASA research grant created to compliment environmental data taken by satellites with ground-level research. The ground-level environmental data in the project could potentially increase with citizen participation. The goal of our project was to assist DEW by documenting the data collection process in order to develop educational and expansionary resources to facilitate future user involvement. We achieved our goal by collecting vegetation imagery, analyzing the images with DEW software, and developing educational tutorials. Through the implementation of our recommendations, the DEW project can increase its effectiveness in monitoring ground-level environmental data.

Executive Summary

Environmental monitoring has become a main focus due to the rise of global temperatures. As more and more images are being collected by environmental monitoring satellites, a need for ground-level images to corroborate the satellite images has arisen. It is under this requirement that the Digital Earth Watch project functions. The Digital Earth Watch project makes use of ground level images from Pictures Posts to monitor environmental change. From here the images are analyzed with the DEW software and uploaded to the Picture Post website. These images can then be used by NASA to corroborate the existing satellite images, as shown below in figure 1.

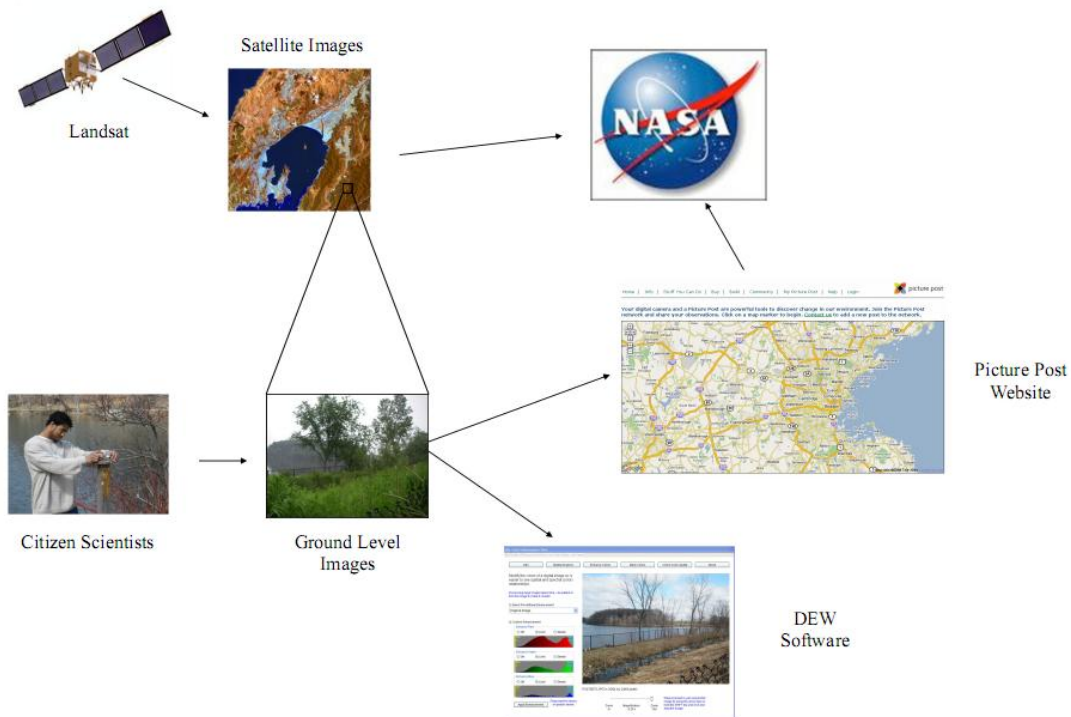


Figure 1: Environmental monitoring data and the Picture Post process

A Picture Post is a tool used to collect these photos from a known location and orientation. This is accomplished through the use of a RAPcap, or Repetively Accurate Photo Post-cap. This RAPcap consists of an octagon attached to a platform which you place your camera, allowing a picture to be taken in each of the eight cardinal directions. With this tool a citizen scientist can collect images to create a panorama of the

surrounding vegetation as well as an image of the current weather conditions and vegetative canopy. This vegetative data is then uploaded to the Picture Post website.

Our goal was to assist the DEW project by obtaining firsthand experience with the Picture Post process in order to develop educational and expansionary resources to facilitate future user involvement. This was accomplished through bi-weekly visits to two different picture posts to collect imagery throughout the term. Then, using these images, we analyzed the images using the suite of Digital Earth Watch software. From this experience, we created a series of concise video tutorials and educational resources to inform citizen scientists of the Digital Earth Watch project.

There are two posts in each of the parks we visited, Fresh Pond Reservation, in Cambridge, MA; and Menotomy Rocks Park, in Arlington, MA. In each of these parks the presence of the Picture Posts and their purpose was not explained. They were unmarked and not placed in a visible and easy accessible area. Because of this, we created signs to be posted in both parks explaining the purpose of the posts and how users can contribute. In order to provide a temporary solution to these problems, we created signs for the Picture Post that included a set of directions on use and also the website where pictures can be uploaded. *We recommend that future Picture Posts include the instructions silkscreened directly onto the post to prevent vandalism or weathering. We also recommend that each site have at least one individual take responsibility for the upkeep of each post.*

The next step in the Picture Post process we participated was the analysis of the images using the Digital Earth Watch software. Using this software, the vegetation can be analyzed between pictures to track environmental health. Although the software has taken a step forward from a series of separate tools into one package, several improvements can still be made. *We recommend that the software run automated scripts to reduce the work required from the user. We also recommend that the software not only be available for download in a single file but also be able to run directly on the Picture Post website.*

The final step in the Picture Post process is uploading the pictures to the Picture Post website. This process has been the major hindrance to citizen science participation in the Picture Post project. In the past, Picture Post operated off of a photo hosting database called Smugmug. The new iteration of the website is hosted directly on an independent

page on the University of New Hampshire website. *We recommend that the new website utilizes a more streamlined uploading technique that draws the required information directly from the pictures as well as individual user profiles and pages to provide a more community feel to the program.*

In order to educate future participants of the Digital Earth Watch project we created a series of video tutorials. These tutorials encompassed both auditory and visual learners by the inclusion of both audio instructions and a visual walkthrough of the process. The first of these tutorials is a general overview of the Digital Earth Watch project and its significance. The second tutorial is an overview of the Picture Post, including both how to locate and use one. The third and fourth tutorials are both centered on the Digital Earth Watch software, first on creating pixel masks and the second on using color layering. To accompany these tutorials storyboards were created to provide a tangible aspect to the video tutorials. *We recommend that these tutorials and storyboards be placed on the Picture Post website where they can be easily viewed by potential and current Picture Post users.*

The current number of Picture Posts allows for only a small sampling of the Boston area as well as the country to be monitored. *We recommend that additional Picture Posts be installed in areas around the local area.* These Picture Posts need to be placed to maximize the amount of vegetative data that can be collected. By increasing the overall number of Picture Posts the amount of data will increase. It must be kept in mind that each post requires a person to maintain the post and prevent and repair any damage that may occur.

Following the conference at the University of New Hampshire, *we recommend that the Digital Earth Watch project continue their efforts to include Picture Posts in other environmental monitoring programs already in existence.* By associating with other active citizen science programs such as BudBurst and ForestWatch, the amount of Picture Post data that can be collected increases dramatically. *We also recommend that the Digital Earth Watch project continue its efforts to coordinate with Groundspeak, and the Geocaching project.* The opportunity provided by Geocaching is immeasurable as the number of people involved in that project provides the opportunity for a near limitless amount of environmental monitoring data.

Assuming the Digital Earth Watch project continues the positive steps it is taking forward, as well as taking into consideration the previous recommendations, the number of users and their involvement will continue to increase. The first step is the completion of the new Picture Post website; with this the construction of the digital repository of images can begin. Once this website is complete and fully functional, the next step is to recruit additional citizen scientists through other citizen science groups and online social networks. With these steps the Digital Earth Watch Project moves closer to its goal of becoming a sustainable source of ground-level environmental data.

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1. Introduction

Over the past few years, there have been several NASA-funded research projects with trial explorations involving citizen volunteers in environmental monitoring. In its last year at the Museum of Science, the *Measuring Vegetation Health* project focused on how the public could help research climate change. The next step for this project was preparing for the transition into a larger organization, under the title of the Digital Earth Watch (DEW) project. This project is a collaborative effort between NASA, the Boston Museum of Science, local New England universities, and citizen scientists working to track climate change. The transition entailed the creation of an improved website, the shift of the NASA research grant to the University of New Hampshire, and a need for more consistent citizen science involvement for data collection.

Generally, environmental data is collected by scientists through research. However, it cannot always be sufficiently obtained. Because of this, relationships have been forged between trained research scientists and volunteers called “citizen scientists.” Together these groups collect a larger amount of data, which allows research endeavors to become more fruitful. Many times this information is of environmental consideration, focusing on topics such as water quality standards, ecosystem health and climate change. The DEW project utilizes citizen scientists specifically for this purpose with the use of Picture Posts (See figure 2). These inexpensive stands allow users to take environmental photography from an exact location over a period of time. However, contributions have been minimal; therefore, further expansion of this project is possible through the increased involvement of volunteers.



Figure 2: Picture Post

The opportunity to expand awareness to citizen participants can be beneficial because it could increase the overall contributions to the DEW project. One way to increase these contributions is to develop educational resources for new participants. In order to develop these educational guides, a further understanding of the Picture Post process was needed. In addition, an investigation could be made into effective ways to expand the awareness of the project through onsite improvements and online social networks. *The goal of our project was to assist the DEW project by obtaining firsthand experience with the Picture Post process in order to develop educational and expansionary resources to facilitate future user involvement.*

For proper direction in our project, we started with a discussion of several different background considerations regarding the DEW project and our goal. From this research, we formed three major objectives to complete our project goal:

1. We documented the Picture Post process in order to gain feedback and find potential improvements.
2. In addition, we developed educational resources to help create an easier way for new participants to get involved.
3. Lastly, we increased the potential for expansion using Web 2.0 concepts as well as by making improvements and additions to local New England Picture Post sites.

Through these methods, we will gain more insight on how to enhance and expand the DEW project.

2. Background

2.1 Introduction

The Digital Earth Watch (DEW) project has the potential to become a powerful environmental monitoring system, starting as a locally based program with the aspirations of growing to a national and potentially global stage. As an organization, the DEW project is still in its development stage. Several key issues have prevented the program from increasing its resources. We have taken certain measures to provide recommendations on how the DEW project could improve and expand. In order to help the project, different topics were researched to assist in forming these recommendations. First, we took interest in the background and recent history of the DEW project, as well as the different technology involved with environmental monitoring. Secondly, we considered the concept of citizen science, how it could expand the overall volunteer base, and some of the risks involved with amateur scientific data collection. Next, we investigated methods of incorporating new technologies to provide solutions for the educational and expansionary aspects of the project. We finished with a discussion of the issues faced when recruiting volunteers into citizen science projects. The main topics discussed in this section allowed us to form our approach to complete our project goal.

2.2 History of the Digital Earth Watch Project

Although NASA already has the ability to track climate change through satellite imagery, they are lacking the ability to link it to ground level monitoring. The need for ground level monitoring provides the perfect opportunity for the involvement of citizen scientists. To improve the lack of citizen involvement, the DEW project attempts to take advantage of current environmental monitoring technology and citizen science in the local area. The project is a collaborative effort between the Boston Museum of Science, several local New England universities, and citizen scientists. These organizations are tracking climate change through community involvement for the purpose of citizen

education. The DEW project relies on citizen scientists to measure environmental land cover changes through digital imagery. The principal investigator, Brian Rogan (personal communication, March 23, 2009) explained that NASA has funded different projects, but has recently grouped them together to form the DEW project. A one-year grant extension has been given to the University of New Hampshire to help this transition.

Our project primarily focused on the Museum of Science’s involvement in this transition. In its last year of participation, there was a need to help finalize some of the developments made by the museum over the last few years. Picture Post technology used in the DEW project was an area of focus for the museum. There was also an interest in the *Digital Earth Watch* software, which involves digital imagery analysis of landscape and vegetation. These projects provided learning opportunities for the local community regarding the environment, utilization of cameras, and digital imagery analysis. The following table (John Pickle, 2006) reviews potential environmental monitoring and educational opportunities.

Observed in Landscape Pictures	Value to Environmental Monitoring	Value to Education
Plants 1) Species – Type & Size 2) Leaf Cover – Amount & Color 3) Flowers & Fruit – Amount + Timing of Events	<ul style="list-style-type: none"> – Ground truth/verify analyses of satellite products used in research and operations – Track invasive plants – Monitor plant response to changes in local, regional, & global environmental conditions & determine important field sites – Support local to international phenology networks 	<ul style="list-style-type: none"> – Watch & measure plant growth – Watch seasonal changes in plants and how these change over years – Expand local understandings to regional, national, and global conditions – Prepare & extend visits to parks (visit is a “snapshot” in time) – Monitor nature’s recovery from natural disasters
Land Surface 1) Type 2) Erosion	<ul style="list-style-type: none"> – Measure erosion rates – Measure snow depth – Measure location of glaciers 	<ul style="list-style-type: none"> – Integrate in geography and geology activities – Relate weather, new development & landscape processes
Water Levels 1) Tides 2) River & Streams 3) Lakes, Ponds, & Puddles	<ul style="list-style-type: none"> – Monitor flooding response to rain events – Expand water level monitoring network 	<ul style="list-style-type: none"> – Watch & measure flooding in response to precipitation – Compare tides at beach and nearby estuaries – Monitor shoreline changes in lakes and streams in response to weather & new development
Sky – Clouds, Sun Location, Sky Color & Visibility	<ul style="list-style-type: none"> – Verify cloud analyses using satellite data – Expand visibility network 	<ul style="list-style-type: none"> – Compare what observed with satellites and what observed looking skyward – Study seasonal location of sun in the sky by monitoring shadows
Buildings/Development 1) Houses to Industry 2) Roads	<ul style="list-style-type: none"> – Long-term monitoring of landcover, including identifying lawn cover, using satellite imagery 	<ul style="list-style-type: none"> – See changing landscapes due to human decisions – Monitor recovery from disasters

Table 1: Environmental and Educational Value of the DEW Project

As shown, there are different opportunities for environmental monitoring and public education if the program is improved. The next step involved a thorough investigation of Picture Post and the *Digital Earth Watch* software.

2.2.1 Picture Post

One of the major developments in the DEW project was the creation and installation of inexpensive photography stands called “Picture Posts.” These stands allow citizen scientists to take photos from an exact location over a period of time. These locations could therefore be easily monitored for environmental health trends of the local area. Monitoring this landscape change through digital imagery could be a productive enterprise between scientists and the public. Images taken over a period of time, in the same location with the same orientation, can offer a great deal of information that can be observed and measured. This information can include vegetation growth and depletion, snow and ice coverage, and plant coloration change

A Picture Post utilizes a simple instrument called a RAPcap (Repetitive Accurate Picture Post – cap) placed on top of a post anchored into the ground. Posts are made from a durable recycled plastic to minimize degradation over time, which increases cost effectiveness. Each cap has a square or circular disk with an octagon protruding from it. This easily allows the user to create a panorama in less than a minute. Photographs are taken with the back of the camera placed on the RAPcap against the each edge of the octagon. Eight pictures are taken, one at each of the cardinal and ordinal directions, starting at North and completed in a clockwise manner. A ninth photograph is taken in the skyward direction with the back of the camera placed on top of the octagon, to provide reference of weather and vegetation coverage. The following figures show the octagonal shape and different directions making up the panorama:

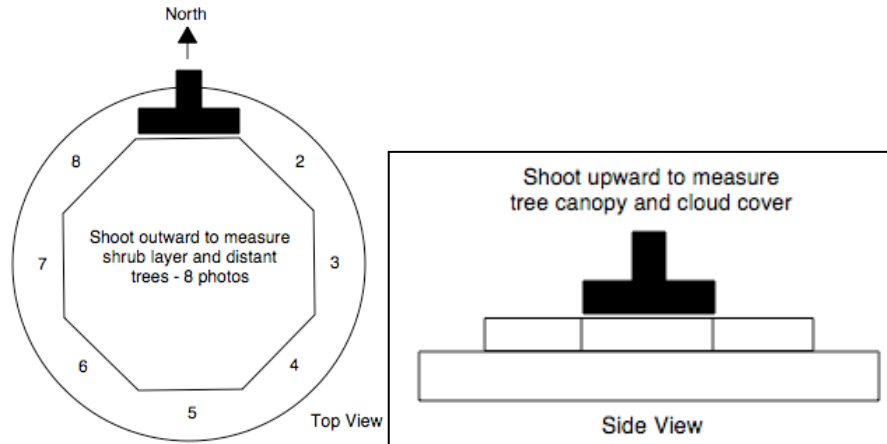


Figure 3: Picture Post RAPcaps provide a panoramic view

It is evident that modern technology can directly aid in the monitoring of vegetation health. Plants incorporated in the local landscape are, as John Pickle stated, “like “green canaries” because if they die other organisms will ultimately follow.” One main aspect of the DEW project is the investigation of vegetative health in local areas by measuring conditions that affect local organisms. Digital cameras allow us to monitor plant health using the proportions of light reflected from leaves. Combining this information with known plant behavior and physiology quickly helps with the assessment of the local environment. Thus, images taken from Picture Posts provide valuable scientific information to monitor environmental change while providing a rich resource for local students and citizen scientists to learn about their local environment.

2.2.2 Digital Earth Watch Software

The Picture Post photo collections utilize an easily downloadable program called *Digital Earth Watch* software. DEW software allows users to analyze digital images to extract vegetative data. This is accomplished through analyzing three main aspects of the digital imagery. First, there is the use of spatial analysis. This assigns a known size to each pixel and uses this to find the size of objects in a picture. Secondly, color enhancement is used to alter the visible colors of the picture, which allows the isolation and visualization of certain colors. This is accomplished using color filters in different combinations. The third type is color masking; this extracts only pixels that are within a

certain color range. This allows the user to isolate and mask the areas of a picture that are of a certain color. Using this in conjunction with the spatial analysis tool allows the measuring of the area and percent of a picture that contains a certain range of colors. Figure 4 is used in as an example below to show that ~24% of the picture below is green, with the masked image on the right. An additional use of the software exists in a certain subset of tools used to compare change over time.



Figure 4: DEW software can filter green pixels

To measure the change and difference between two photos first the photographs must align perfectly. For this to be accomplished, the pictures must be trimmed down to an equal size and shifted into perfect alignment. For most pictures, the conditions may not have been identical when they were taken. Thus small differences may be visible between the two photos due to a different lens or zoom. These differences must be

accounted for by using stationary landmarks to size and align the pictures. After the images are aligned, the color filters are again used to create a grayscale version of each image. Next, the *Combining Pictures* tool is used to assign each grayscale image to a different color in the final image. This allows any portion of the image that may have changed to be seen as an individual layer in the final image, while things that remained constant appear gray. This allows for visualization of individual changes to be analyzed between pictures, as shown in Figure 5. This figure shows how the runner that appears pink on the left was only present in one picture. Most substantive differences are not visible until a longer time scale and a larger data set is used.

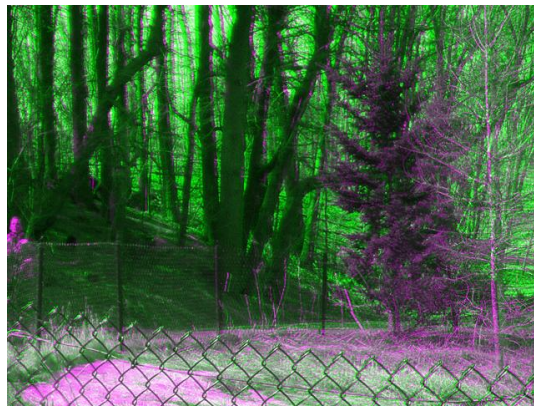


Figure 5: Overlapped imagery

Several powerful analysis tools give a wide array of citizen scientists the ability to analyze digital imagery. The use of spatial analysis assigns a known size to each pixel allowing you to find the size of objects in a picture. Color enhancement uses different combinations of color filters to alter the visible colors of the picture, which allows certain colors to be isolated and visualized. Also, color masking extracts only pixels that are within a certain color range allowing the user to isolate and mask the areas of a picture that are of a certain color. These different methods of analysis provide opportunity for ordinary citizens to begin understanding their local environment, thus making it an important part of the DEW project.

2.3 Understanding Volunteer Involvement: Citizen Science

The foundation of data collection for the DEW project is most prominently made up of community volunteers. These citizen scientists are a group of amateur investigators who participate as field assistants in scientific studies. They collect ecological data without receiving any sort of compensation or formal training. Cohn (2008) has found that most citizen scientist assist with ecological research because they love the outdoors or are concerned about environmental trends and problems. Volunteers can be quite useful for gathering scientific information because in many cases there are not enough people in the professional scientific community to sufficiently collect all the necessary information. Cohn (2008, p. 193) affirmed that professional researchers “can employ citizens to gather data that we cannot get any other way.” Thus, citizen science is fundamental in acquiring environmental monitoring information for the DEW project. There are benefits to developing a community of citizen scientists, but citizen volunteering brought other important considerations of the risks involved with amateur collaboration.

One such problem that has arisen in citizen science is the quality of the data collected by volunteers. As Galloway (2006) stated, “studies regarding the volunteer or student data quality have reported mixed results. Some report a general consistency between data collected by volunteers and professionals and others report mixed or questionable results.” This variation occurs for a few different reasons. Some of the issues include objective citizen analysis, volunteer skill level, and the overall demands based on the scope of a project. In relation to the DEW project, the quality of the photos taken by citizen scientists must be brought into consideration. While it has been shown in previous years that citizen scientists can learn to use Picture Post equipment and collect data that is accurate, expansion of the DEW project must maintain this accuracy in order to uphold the standards that have come with Picture Post technology.

Volunteer involvement within the DEW project has shown to be a vital aspect for data collection. NASA has shown interest in ground level vegetative monitoring amongst citizens because it allows for a wealth of data collection that otherwise could not be obtained. Keeping in mind these considerations, proper instruction must be provided in

order to maintain the accuracy of data collected. Once these problems with citizen science were properly addressed, we were able to consider the type of educational resources that the DEW project would need for future sustainability.

2.4 Educational Resources: Video Screen Capture Technology

As the DEW project began to develop into a larger organization, it became important to recognize the need for proper educational techniques to sustain and increase citizen scientist involvement. One particular type of educational tool that has been utilized to effectively teach scientific topics is video screen capture software. This type of program creates videos from recorded live computer screen action to enhance instructional value in a tutorial format. There are three areas where we investigated the utilization of such software. First, there has been previous implementation of this educational tool in an academically rigorous environment. At the University of North Carolina School of Medicine, Woosely (2004, p. 122) stated, “Video dermatopathology tutorials are extremely effective because they closely mimic instruction at the microscope.” This provided proof of the software’s ability to help visualize a type of scientific observation. Woosely (2004, p. 122) added, “They offer the significant advantage of allowing remote teaching at any time or place convenient for the learner.”

Due to the existence of several different learning styles, it is important that our methods for educational resources are effective with all types of people. Today, theorists suggest there are three different styles of learning including: visual, auditory, and kinesthetic or tactical. Auditory learners prefer to get information by listening, while kinesthetic or tactical learners prefer hands-on learning such as making models, doing lab work, and role playing. Visual learners learn best with the use of a multi-sensory approach provided by movement, color, graphics, and sound. The benefits of visual learning software have been found in investigative research of educational methods. In 1999, McCormick (p. 4) stated that approximately “60 percent of contemporary students are visual learners.” In addition, Gromick (2007, p. 92) stated, “Video modeling tutorials are an effective approach to delivering all forms of content, from simple constructions to more complex explanations”, explaining his positive experience with video screen

capture programs in foreign language instruction. This has provided proof that it has been advantageous to utilize such programs. Video tutorials create a visual and auditory experience for the learner and have a diverse range of educational capability.

Although the literature shows video tutorials to be beneficial in previous educational situations, it is necessary to evaluate the tutorials in our project. A popular method in doing so is the use of surveys. Surveys ask the user's personal experience in regards to a process or any area of interest (Kichenham, 2006). Incorporating surveys into the evaluation of the video tutorials is necessary in order to verify that they are effective and beneficial. If they aren't, another method of educating future users will need to be used. If the surveys show that they are a positive educational method than further tutorials can be made to expand the DEW project.

This software has also been utilized previously in the DEW project. John Pickle has developed Camtasia tutorials for the various capabilities of the *DEW* software. The three areas where we were able to identify the benefits of video screen capture software were in an academic environment, as a visually based learning tool, and as a historically utilized educational program in the DEW project. This provided some viable proof that it could help us achieve our goal of developing educational resources for the DEW project.

Before we could fully make use of this education tool, it was important to gain an understanding of the software. First, we took an introductory seminar on using Camtasia Studio at the Gordon Library, at Worcester Polytechnic Institute. This provided us with a background on how to create the video tutorials. In addition, we investigated any limitations or issues involved with using the software. The major issue that was identifiable with creating these video tutorials was computer-processing needs for their creation. John Pickle has also attested to this, stating the need to create the videos in short lengths to help avoid any computational errors in the processing. Once we took all of these points on video screen capture technology into consideration, we were able explore other types of resources that could be beneficial for the DEW project.

2.5 Web 2.0 and Crowdsourcing

There were several issues suggesting that the interface between citizen volunteers and scientists should be closely analyzed. As the DEW project transition has occurred, it has been important for our team to assist this relationship in order to expand the program without detrimental changes to the quality of the data collection. It became apparent that the new website for the DEW project must provide educational resources for the various citizen scientist groups to conduct photo research and report their data properly. Following Cohn (2008), the website should provide a location where collaborations between scientists and volunteers have the potential to broaden the scope of research and enhance the ability of scientific data collection. The DEW project could benefit from a situation where there is minimal effort required for citizen scientists to contribute to the research. One potential method of foreseeing this improvement is through the application of Web 2.0 technologies.

Fabio Carrera, a professor at Worcester Polytechnic Institute, became involved in the project as it transitioned to *Digital Earth Watch*. His particular interest in the project deals with the utilization of a concept called Web 2.0. “Web 2.0 has gained much attention as a revolutionary way of managing and remixing online data, enabling interoperability across heterogeneous data sources” (Zhang, 2008, p.2). The concept poses an opportunity for scientific information to be shared and distributed to a larger overall community. The term originally was termed by media analyst Tim O’Reilly. He (2005, p. 5) stated, “An essential part of Web 2.0 is harnessing collective intelligence, turning the web into a kind of global brain.” With respect to the DEW project, the ability to effectively share data could allow the users to become more educated and involved.

Using Web 2.0, data can come from a broad array of sources and it can be made available to the larger population and scientific community. This concept is also known as crowdsourcing. Crowdsourcing, or the collection of information using large groups instead of trained professionals, has become a common practice using Web 2.0. It provides opportunities for cost reduction and data source expansion using volunteers. Brabham (2008) states that there are differences between a crowd and a design team in terms of data collection. While a team relies on groups of experts, the crowd relies on the

presence of amateurs. The data collected from a “design team” of scientists is more of a final product, while data from crowdsourcing is unprocessed.

Crowdsourcing has the distinct advantage of creating a larger reservoir of data than what a team of highly trained experts could create alone, similar to citizen science. This concept is beneficial to the DEW project because of its need for an increase in data collection. With this current need for expanded data resources, various online social networks can be utilized to increase the overall involvement of the program. The development of a personal community, in opposition to the anonymous submission method that is currently used by the website, could facilitate retention in Picture Post involvement.

On the current DEW website, hosted by Smugmug, the pictures are organized in a confusing manner. This is caused by the fact that the photos are organized solely by their orientation. This confusing organization method allows the photos to be viewed only on an individual scale, and not as part of a set. Through the proper organization of the photos, the process of browsing will become a hands-on experience that allows the visualization of the vegetative change. If Web 2.0 technologies are utilized, information will become more accessible and easy to organize by multiple properties rather than just by photo orientation. Web 2.0 could facilitate the growth of expansionary resources, and as more information is collected into the overall data set, the easier it will be to identify significant environmental changes. This is possible because an improved photo-browsing layout on the website could retain user interest and thus overall involvement.

In 2006 John Pickle (p. 2) stated, “For over three years, Picture Posts have been in prototyping to test if the photographs and an Internet site could be used to scale up to support a national environmental monitoring effort run by citizen scientists”. Through proper organization of the Picture Post information, the DEW project can move one step closer to providing sustainable environmental monitoring on a local level with the internet. Huberman (2008, p. 8) stated, “Crowdsourcing exhibits a strong positive dependence on attention.” Although these benefits were recognizable, one of the downfalls of crowdsourcing is a problem with user commitment.

In the past, the DEW project has recruited people from organizations such as schools or non-profit organizations. One major problem facing the project is maintaining

user retention. In the current state of the project, there is a limited amount of contributors but as the project grows, the amount of available information will consistently increase if user involvement is retained. “The dilemma ensues when every individual [feels that the project can operate] on the efforts of others, making everyone worse off—thus the tragedy of the digital commons” (Huberman, 2008, p. 2). To prevent this there must be a concentration to add a certain “wow factor” which involves items to catch and retain user interest in the project. This new interest could be possible with different Web 2.0 technologies.

In order to move the DEW project into Web 2.0, different types of technologies must be explored. Within a blog, users can publish their own writing, analyze others through peer review, collaborate on projects, and manage digital portfolios. A professor once organized an experimental blog-based environment in which students could access course material, post findings, comment on each other’s contributions, post reflections, and easily communicate throughout the experimental period of one semester. At the end of the semester, the study showed that blogging facilitated and contributed to the students’ learning. The students felt that “accessing and reading blogs of others” (p. 182) contributed most to their learning. They enjoyed learning “new things from others’ perspectives” (p. 182), seeing the progress of others, and receiving comments on their work (Churchill, 2008).

The use of these Web 2.0 technologies along with the concept of crowdsourcing can do wonders in the revamping of the current DEW project website. Interface of citizen scientists with new Web 2.0 technologies for the DEW project may increase both the number of users and sustain their involvement in the project.

2.6 Expanding Information Sources and Recruiting of Citizen Scientists

Active recruitment can increase participation and ultimately lead to continuous contributions to the DEW project. As evidenced by programs such as NatureMapping, Forest Watch, WaterWatch, and the Citizen’s Environmental Watch, it has become apparent that a diverse set of methods can be used to achieve sustainable data collection. Based out of the University of Toronto, Citizens’ Environment Watch (CEW) was

initially founded in 1997 to monitor surface water samples in the local area. Much like the DEW project, participation came from high school students aged 12-17 (Savan, 2007). While it took several years to develop a strong set of data resources, CEW now has “over 65 community groups and schools to regularly collect monitoring data that identify potential environmental concerns” (Savan, 2007, p. 561). By effectively utilizing similar methods as the CEW program, DEW can expand its data sources and interactively sustain its user base.

Public school systems are one type of volunteer group that has proven to be of great use as citizen scientists. Unfortunately, DEW has involved only a small number of educational groups. The project should further access the local New England school systems to a greater degree. One important deliberation is why schools have not been more involved. Upadhyay (2005, p. 94) asserts, “Research shows that urban students have to see some kind of connection between their science learning and lived experiences.” This can be applied through the on-site opportunities of photo collection and uploading, as well as the gained knowledge of the local environment and climate change. These methods must be designed to engage the local schoolteachers, administrators, and students in order to form a partnership between the DEW project and the local public school system. In forming this community, we also must consider our cultural districts when developing presentation methods and online tutorials for the local curriculum.

Other organizations have been successful by incorporating different options for participation. With various degrees of participation, there could be an increase in the level of interest, volunteer retention, and ultimately the number of participants in the project. If users have a choice to either set-up a new Picture Post or visit a pre-existing one, they will be more likely to choose the path that works best for them. As evidenced by frequent visits, several Picture Posts are old, hard to find, or do not include any sort of directions for use. Expanding the overall presence of the posts at certain sites can potentially incorporate more users. Also, by allowing document of their own neighborhood vegetation health by improved freedom upon where the monitoring will take place may draw more users. These new opportunities for involvement allow the

expansion of the project through the recruitment of more citizen scientists or even everyday people that discover the Picture Posts.

Researching existing programs that have similar long-term goals to the DEW program is a key aspect in determining and utilizing potentially beneficial practices for the project. Dvornich (1995) mentions that the success of the NatureMapping project was primarily by spreading awareness through word of mouth. Word of mouth has evolved in recent years to the current existence of online social networks. Online social networks allow users to share information about various activities and interests. By incorporating the DEW project into online communities such as Facebook, the overall awareness of the project can be increased and ultimately broaden the project's long-term resources.

2.7 Summary

The important areas of expanding citizen science in an environmental monitoring project have been broken down into several key points. First, when considering academic volunteering, it is important to maintain an interactive process in the project to keep students and teachers interested in continuing involvement. Next, the option of providing different levels for user contribution can make it easier for a wider base of citizen scientists to get involved in the project. Lastly, using online social networking opportunities provides the potential for expansion of the DEW project. These different concepts will help us consider a variety of ways that the DEW project can maintain user interest and expand upon its resources of data collection. Using this we are led to the creation of a methodology, which can lead the DEW project towards its goal of self-sustainable user involvement.

3. Methodology

3.1 Introduction

In order to assist the DEW project, we explored several strategies to provide a concise set of recommendations for ways in which to expand citizen science involvement. We worked towards this improvement in three main ways.

1. Through firsthand experience, we documented the Picture Post process to experience the procedure of an end user.
2. Next, we developed educational resources such as video tutorials and live demonstrations for new participants to the Picture Post process.
3. Lastly, we worked to expand the overall awareness by creating a Web 2.0 foundation, presenting at a citizen science workshop, and improving/increasing the Picture Post sites.

These different objectives provided us with the opportunity to make a diverse set of recommendations for improving the DEW project.

3.2 Objective 1: Documenting the Picture Post Process

In order to properly document the Picture Post process, it was necessary to experience it firsthand. In doing so we familiarized ourselves with the three main steps of the overall procedure. These included taking the photos at the Picture Post sites, applying *Digital Earth Watch* software to our digital images for measuring vegetation health, and uploading the photos to the new website. This course of action was documented in order to help make the Picture Post process easier for citizen scientists.

3.2.1 Biweekly Picture Post Visits

We visited two local Picture Post sites twice a week while we were in Boston in order to develop an understanding of the Picture Post process and to obtain a large collection of photos for analysis. Located at Fresh Pond Reservation in Cambridge and

Menotomy Rocks Park in Arlington, each location had two Picture Posts that we used to monitor the different scenery. The process for collecting the Picture Post data was developed by previous Principal Investigator John Pickle. During each biweekly visit we took the eight photographs around the octagonal RAPcap to provide the panoramic view of the Picture Post (See figure 6). The camera recorded both the date and time of data collection. This provided us with a timeline for the photos collected. The digital camera was set to its default mode in its widest-angle lens setting to get consistent digital imagery for future analysis. Beginning in the North direction, the camera was aligned against the back of the octagon and rotated clockwise for each additional picture. A skyward photograph was taken after the panorama collection was complete in order to reference the weather and overhead canopy. These photographs allowed us to acquire an understanding of the qualitative standards set at each Picture Post site, and gave us a personal data collection for vegetation imagery analysis.



Figure 6: Picture Post visit

3.2.2 Analyzing Pictures Using *Digital Earth Watch* Software

To gather additional understanding of the local area, we analyzed the photographs using the *Digital Earth Watch* software. This software allowed us to quantify vegetative health using color filters as well as visualize change over time. First, the photos were uploaded to the computer using a USB connection or memory card. Then, we opened the relevant photos using the software. Using the masking tool, as shown in figure 4, a masked layer was created showing all the pixels containing the green spectrum as black.

Then the masked image had the spatial analysis portion of the software applied, giving a quantification of how much biomass is present in a given picture. Alternately, a color filter was applied to isolate a grayscale version of the picture. By applying this filter to multiple pictures from the same position on a post, the change over time can be visualized (See figure 4). This was accomplished by applying different dated pictures to each color layer of an image using the combining images tool in the software as show in figure 5. This process often required the images to be trimmed and scaled so that objects in each picture are aligned, as was done using the trimming images tool. By visiting each site biweekly throughout the term, a large amount of digital imagery was obtained in order to assess any growth or decay in the area. After the analysis of the photos, we were able to continue to the next phase of the process; uploading to the *Digital Earth Watch* website.

3.2.3 Uploading to the New Website

While the website was preparing to be opened to the general public during the transitional phase of the DEW project, we developed a basis of understanding on the new login process and created our own user profile to actively share and examine our Picture Post photos. Due to the limitations of the website the ability to upload is not active on the current new Picture Post website. We used our experience to gather feedback dealing with different navigational features of the new DEW website. In addition, we documented any potential challenges that new Picture Post users might have with website navigation. The next step of our project involved the creation and evaluation of educational resources for new participants in the DEW project to guide users through the Picture Post process.

3.3 Objective 2: Creation of *Digital Earth Watch* Educational Materials

3.3.1 Familiarization with Video Screen Capture Software

In order to further educate the citizen scientists used for the data collection in the

DEW Project, Jing software was used in combination with Sony Vegas Pro 8 to create a series of instructional tutorials for the Picture Post process. Jing is a program that is used to capture the state of your computer and record actions on the screen as they occur. A microphone was then used to add in an additional voice track with verbal instructions explaining each action taken in the process. Finally once a video and an audio track are recorded Sony Vegas 8 will be used to edit and compile the videos to a final production state. The first of these tutorials explains the proper use of the Picture Post, as explained in section 1.3 of the Background. The second tutorial refers to the *Digital Earth Watch* software and its use in order to analyze and quantify the vegetation in an individual image. This tutorial is in two parts, the first of which discusses the use of the tools for spatial analysis, and the second of which discusses the use of the software to visualize changes between individual images. First, we must look at how to properly capture and document the use of a Picture Post to capture the set of images used by the DEW project.

3.3.2 Picture Post Tutorial

In creation of the Picture Post tutorial, a series of still photographs were taken of a group member using the post. By providing a visualization of each step in Picture Post usage, and having them be accompanied by an audio explanation of each task as it is undertaken, the viewer gains a more in depth understanding of each of the steps in the Picture Post process. These methods also incorporated the various types of learners that may use the posts. Visual learners benefit from these tutorials by viewing the steps of the process, auditory learners benefit by the hearing the instructions for use and kinesthetic learners are able to conduct the process after viewing the tutorial. By providing an in-depth description of each step undertaken in the use of a Picture Post, the resulting pictures taken by users will be more consistent from case to case. This then leads us to the next tutorial, which covers the use of the *Digital Earth Watch* software.

3.3.3 Digital Earth Watch Software Tutorial

The tutorial on the use of the *Digital Earth Watch* software was split up into two main parts, the first of which discusses the use of the program to measure the biomass of the vegetation in a given image. The tutorial shows a step-by-step walkthrough of how to isolate and measure the percentage of green vegetation in an image. The second part of the tutorial shows how to use the software to display the change between up to three different pictures. A video of the process was captured using the Jing software and was imported into Sony Vegas Pro 8 for editing and combining with the audio track. This process, as documented in section 1.4 of the background, is accented with a verbal walkthrough along with a step-by-step visual instruction allowing the average user to produce visual results that can track environmental change over time. This tutorial follows the same format as the Picture Post tutorial in allowing people of all three learning styles to benefit from watching and interacting with the tutorial and the *Digital Earth Watch* software. The next tutorial will also use the screen capture software to detail the use of the newly produced Picture Post website.

3.3.4 Tutorial Evaluation

In order to obtain external evaluations of the tutorials created for the Picture Post project we set up a table at the Fresh Pond Reservation during the Cambridge Science Festival. This table allowed us to capture a sample of the target audience of the project. This sample of people took the time to view the tutorial and then participate in the use of a Picture Post. After the Picture Post use we asked the participants to complete a brief survey regarding the effectiveness of the tutorials. We also tallied the total amount of participants and tallied the ones who needed additional instruction after viewing the tutorial. This allowed us to analyze the effectiveness of our tutorial in a quantitative manner. From this firsthand experience we gained found ways to improve the current tutorials and the construction of any onsite instructional resources.

3.4 Objective 3: Developing expansionary resources to increase participation in the *Digital Earth Watch* Project

3.4.1 Maintenance and Improvements at Current Picture Post Sites

Through our Picture Post use, it became evident that the Fresh Pond and Menotomy Rocks parks were poorly maintained and needed to receive multiple improvements in order to facilitate increased user involvement. We contacted representatives for each location, Ranger Jean Rogers for Fresh Pond and John Pickle for Menotomy Rocks, and discussed ways to improve each site. Jean Rogers expressed the opportunity to set up a new post in Lusitania Meadows at Fresh Pond to document the landscape changes as well as the growth of newly planted wildflowers. Jean and John both agreed that the wooden posts currently used needed to be replaced with the new recycled plastic posts. We ordered four new posts, two to replace the posts at Menotomy Rocks, one for Lusitania Meadows, and one to replace Picture Post #2 at Fresh Pond Reservation. These posts will last up to fifty years without degradation and have the north direction engraved on the RAPcap. We also developed informational posters and silkscreened post instructions that required no managerial upkeep and provided park visitors with a simple way use and find out more about the DEW project.

3.4.2 Developing a Web 2.0 Foundation

Online social networks were used among citizen scientists in order to help spread awareness of the *Digital Earth Watch* project. The effectiveness of each social network was evaluated at the Cambridge Science Festival with a short survey. This survey evaluated which network the average user would be most likely to use, including Facebook, Twitter, and Friendster. Through the use of this online social network, we created a *Digital Earth Watch* group and reached out to existing organizations with similar long-term goals such as monitoring climate change and vegetation through citizen involvement. The purpose of this group was to keep users up-to-date and involved with the changes associated with the DEW project, and to create a user forum allowing users

to actively communicate. We also periodically updated the existing *Digital Earth Watch* blog, which served as an additional network to update citizen scientists. We were able to embed our tutorials on the blog to receive feedback from our sponsors.

3.4.3 University of New Hampshire Citizen Scientist Workshop

On April 23rd and 24th we presented to the main contributors to *Digital Earth Watch* project as well as to a large sampling of citizen scientist groups in the New England area. These included: Forest Watch, Plant Health, Project Budburst, Groundspeak and Citizen Science Central. We provided the groups with a demonstration on selecting a site and installing a Picture Post. This included a discussion of finding a site with a wealth of vegetative data, recording GPS location, and proper positioning of the post in the North direction. The next involved a demonstration of the *Digital Earth Watch* software which included the use of color filters, photo masking, and spatial analysis. After giving the presentation, we received and provided feedback with the other programs to help the overall expansion of citizen science in the New England area.

4. Findings

4.1. Picture Posts need to be placed in an easy accessible area that is clearly labeled for use.

While we visited Picture Post sites at Fresh Pond Reservation and Menotomy Rocks Park, we were able to identify numerous solutions for increasing citizen science participation. One of the first things we realized was that the Picture Posts were not clearly labeled or even noticeable in the parks. They all blended in with the environment and had no clear markings as to where they were. The figure below is an example of the difficulty seeing Post #1 at Fresh Pond Reservation from the walking path.



Figure 7: Picture Posts are difficult to find

Another issue occurring at several Picture Posts was that the laminated directions stapled to the posts were not durable enough to withstand the weather at the site they were placed. Thus, we found a need for durable site instructions to educate the public on what the Picture Posts were, how to use them, and how to get involved.



Figure 8: Picture Post without directions

The experience we were able to gather at the Picture Post visits was useful in numerous ways. After a few visits, we were able to gather the images at each Picture Post easily. This helped us realize that the real issue behind the lack of data collection was not so much the process, but more the need for increased awareness of the program. Therefore, we found that educating citizen scientists on the Picture Post process was needed.

4.2 The *Digital Earth Watch* Software should be consolidated into a single program and formatted into a more user friendly interface

After using the *Digital Earth Watch* software many shortcomings immediately became evident. The first of these is the name of the software; currently the software is named *Analyzing Digital Images*. The software was originally many separate programs and less indicative of the new consolidation into the DEW software. This leads us to the next issue or the fact that even in its current state the software is actually two training programs and the *Analyzing Digital Images* software unpackaged. The software should not only be packaged under the DEW software title but also be available from the Picture Post website. Once the software is downloaded we found that there was a whole new set of problems.

Once the software is opened a whole new set of issues become clear. First off, there is no instruction as to what the end goal of the software is. The second thing we found with the software is that operations are extremely slow and some take 2 minutes on the fastest of computers. Table 2 shows the time it takes to mask an image on computers with various processing speeds. The next issue that we found with the software was that it is very limited in its function and there is no good way to line up photos for using the color filters. With these findings we were able to create a set of recommendations of ways in which to streamline the software.

	Processor	Masking Time
Computer 1 (PC)	1.83 GHz Core Duo	90 Seconds
Computer 2 (PC)	1.7 GHz Intel Celeron	120 Seconds
Computer 3 (PC)	1.83 GHz Core Duo	95 Seconds
Computer 4 (Mac)	2.2 GHz Core 2 Duo	50 Seconds

Table 2: Benchmarking of DEW software

4.3 New educational materials need to be made that pertain to the latest software version.

After experiencing the Picture Post process we found that the educational materials for the project no longer applied to the program. The software tutorials were based off an older version of the software and didn't pertain to the newest suite; Analyzing Digital Images. Once these tutorials are made they should be easily accessible to the new DEW website for anybody to access.

4.4 The educational materials are effective in educating and informing people of the *Digital Earth Watch* project.

To evaluate the effectiveness of the educational materials, we set up a table at the Cambridge Science festival with a portable Picture Post, tutorials, educational posters,

and a survey. Here, we had the opportunity to interact with the target Picture Post users and found that people thought the videos were both clear and useful in informing people of what the Picture Post project is and the process involved. It was also clear that the majority of people considered the Picture Post process to be easy to complete after watching the tutorial. Through the survey, we found that of more than half of the people were averagely or above interested and planned on continuing involvement. This data is shown in figure .

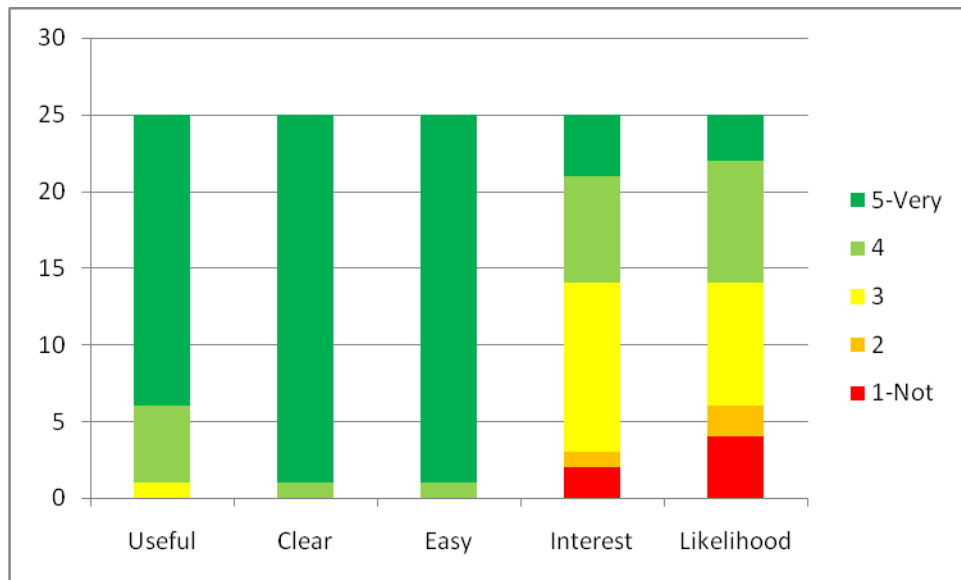


Figure 9: Picture Post Survey Results

4.5 The best online social network to recruit and keep users informed is Facebook.

With the survey given at the Cambridge Science festival, we found that the best social network to keep users involved and informed was Facebook. The second most effective social network to utilize was with wikis or blogs. As shown in figure 10, the

survey justified these findings, and allowed us to utilize the best social network in our methodology.

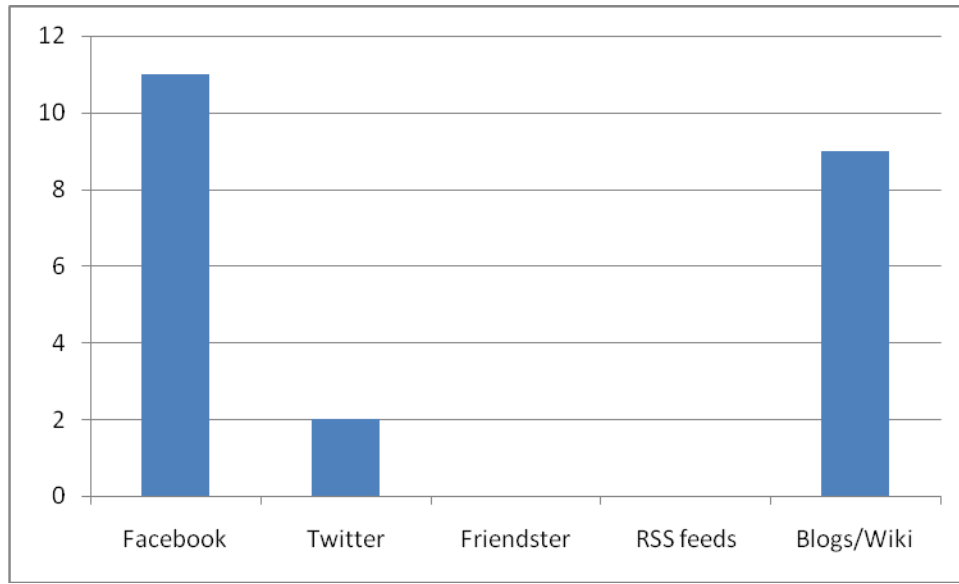


Figure 10: Social Network Preference

In summary, we found a strong need for educational materials both onsite and in the form of video tutorials. After proper evaluation, we found that these methods were effective in both informing people of the DEW project and teaching them how to get involved. With a simple survey at the Cambridge Science festival we learned that Facebook was the best online social network to keep people informed. We also found that a consolidation of the DEW software was necessary and a more user friendly interface was essential in maintaining user involvement. These findings allowed us to prepare a concise set of recommendations to improve and expand the *Digital Earth Watch* project.

5. Recommendations

From the in depth analysis of our findings we were able to draw several recommendations for the advancement and improvement of the DEW project. These fall into four categories, onsite, website, DEW software, and citizen science. Detailed below are our recommendations for each category.

5.1 Onsite recommendations for future work

5.1.1 Replace wooden Picture Posts with more durable plastic Picture Posts

The Picture Posts that are made of recycled plastic can last under decades of weathering, while the wooden posts can only last up to five years before there is a need for replacements. There were a few locations that still used the old style of wooden posts, and the damage was noticeable. Making these replacements would inevitably save the DEW project materials cost over time.

5.1.2 Place silk screened signs at Picture Posts to inform potential users

By adding the metal signs that promote and inform passersby at the different Picture Post locations, it creates a more permanent system of educating citizens about what the Picture Posts are and how they could easily get involved with the environmental monitoring team.

5.1.4 Get “site coordinators” to consistently monitor Picture Post locations

In order for continual site management to occur, it is recommended that a site coordinator be created to monitor and maintain the sites at each park. This will ensure that each site will be in good condition and users will provide accurate data for the Digital Earth Watch project.

5.1.5 Consider new locations for Picture Posts to expand data collection

With an increased number of users, expanding Picture Post locations will be needed in order for the project to continue to grow. It is recommended that the recycled plastic Picture Posts get used to decrease maintenance and increase the time to which posts can be utilized.

5.2 Continued development of DEW website to increase contributions

5.2.1 Streamline the Picture Post photo uploading process

Incorporating a user-friendly upload process with the latest website design will ultimately lead to an increased amount of participants. Making it easy for people to contribute is one step in advancing the Digital Earth Watch project to a high level of contributors.

5.2.2 Develop user profiles on the new website to create an online community

Incorporating user profiles within the website design where volunteers can critique, share, and communicate will recruit more long-lasting participants. Establishing a community feel will provide a foundation for the project and lead to improved data collection.

5.3 Continue development DEW software

5.3.1 Develop a more user friendly interface

Developing the software to make it more user-friendly will encourage more users to analyze their digital images. It is recommended that the overall speed of different operations is increased and the process involved with these actions becomes easier for the average user. This ease can be accomplished through the automation of certain aspects of

the software allowing the user to press a single button and the software will complete the steps towards the result with little personal action.

5.3.2 Allow image analysis to be embedded on DEW website

It is recommended that the DEW software be embedded into the website so users don't have to download the software in order to analyze their images. This way a Picture Post user would be able to analyze the images they upload simply by pressing a button on the website. If it were incorporated in the website more people would be involved with the DEW community and be more likely to get involved with the program.

5.4 Involvement with additional citizen scientist groups

By continuing communication and reciprocal involvement with other citizen scientist groups both will benefit. By providing other citizen scientist groups with Picture Posts and the technology to get involved, these groups can contribute additional images to the Picture Post project.

6. Conclusions

In our time at the Museum of Science, we were able to learn many things about what interfered with the expansion of citizen science involvement. The process of taking and analyzing Picture Post pictures helped us gain a deeper understanding of the DEW project. During the data collection, we were able to analyze the process for its educational potential and identify any issues that existed with the process. Our biweekly data collection provided us with a set of images that helped familiarize ourselves with the procedure. It also helped contribute to the overall DEW repository of vegetation imagery.

There were several unexpected issues that limited our ability to effectively contribute in certain areas of the DEW project. The data for Picture Posts was not ready to be added to the new website. This was caused by the fact that the new website was in the process of being created while we were working on our IQP. There was not any space on the web where potential new citizen participants could contribute their own data or find out more about the DEW project. Although the lack of a prepared system inhibited our ability to promote the project, we used this gap in development to help improve the upcoming website with our tutorials and other deliverables.

The DEW project is on the verge of becoming one of the premier environmental monitoring systems in the New England area. This is due to the ability for anyone to get involved with the Picture Post process. We have provided ways to help the DEW project take the next step towards increased citizen participation. By gaining knowledge of the Picture Post process, creating educational resources, and investigating new ways to expand involvement the project, our team has identified several ways the DEW project can enhance and expand. Through the implementation of our recommendations, the DEW project can increase its effectiveness in the collection of ground-level environmental monitoring data.

7. Appendix

5.1 Picture Post Panoramas

Fresh Pond post 1



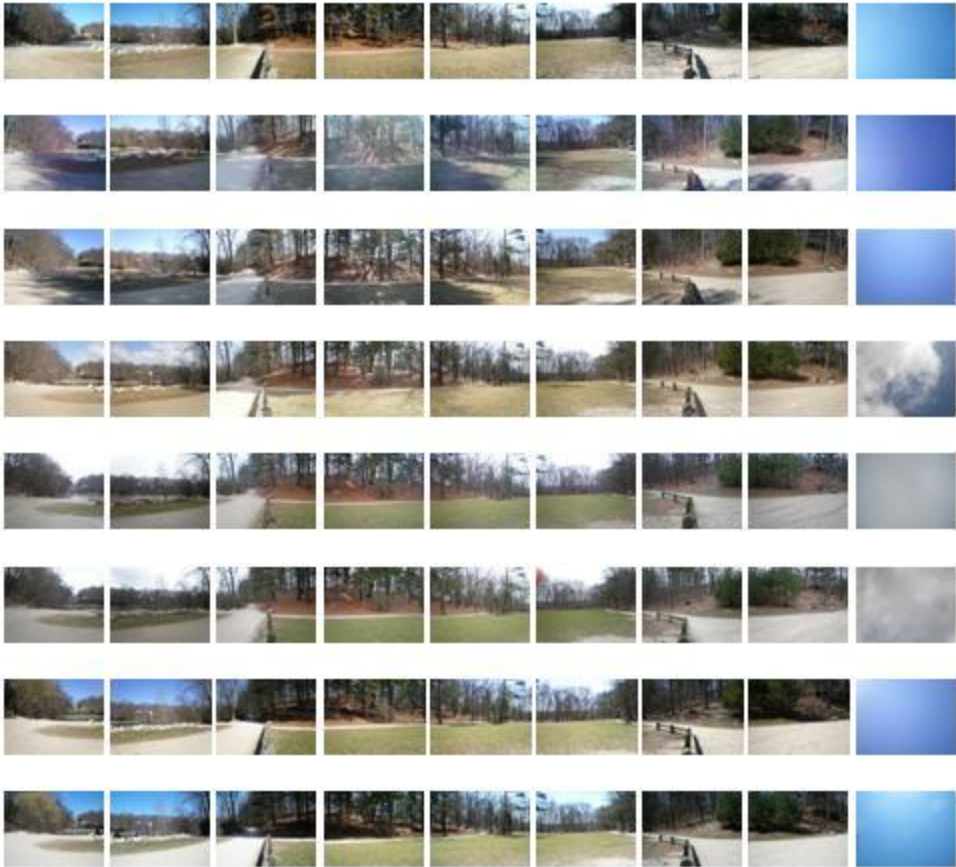
Fresh Pond post 2



Menotomy Rocks Post 1



Menotomy Rocks Post 2



5.2 Tutorial Story Boards



picture post



Hi There, How would you like to learn about Picture Posts?

First off what is a Picture Post?

A Picture Post is an environmental monitoring tool made from recycled plastic or wood in some cases that includes a round top with a RAPcap.

This RAPcap allows the user to take repetitively accurate pictures using the picture post.



These pictures are then used to provide a panorama of the surrounding area.

As you can see, these pictures each contain a wealth of vegetative data that can be used by citizen scientists to contribute to ongoing scientific research.



Now how would you like to learn how to use one?

Locating a local Picture Post is easy by either using the GPS location or by referencing one of the maps available on the website.

When you arrive at the picture post take out your camera and align it along the side of the RAPcap in the marked North direction.

Make sure that the camera is zoomed all the way out and is set to your camera's default picture mode.



Then center the camera on the post and take your first Picture Post picture.

Then continue taking pictures clockwise on each side of the RAPcap until you have taken a picture in each of the eight directions.

Finally take a picture straight up to capture the vegetative canopy as well as the sky.



Congratulations you have now taken your first set of picture Post pictures.



picture post



Welcome to the Digital Earth Watch Project.

I bet you're wondering, what is the Digital Earth Watch project, or DEW?

Well, you see, DEW is the result of a need for ground-level environmental monitoring data.

NASA is consistently collecting environmental data in the form of satellite images.

In order to affirm the information gathered in these satellite images, and gain a look into what is occurring in a single pixel of one of these larger images, DEW and Picture Post were started.

Getting involved is easy.

First visit a local Picture Post and collect a set of Picture Post pictures.

You can then analyze these images using the DEW software.

This software has three major uses, spatial analysis, color enhancement, and color masking.

These are used to measure different health aspects of the vegetation captured in each image.

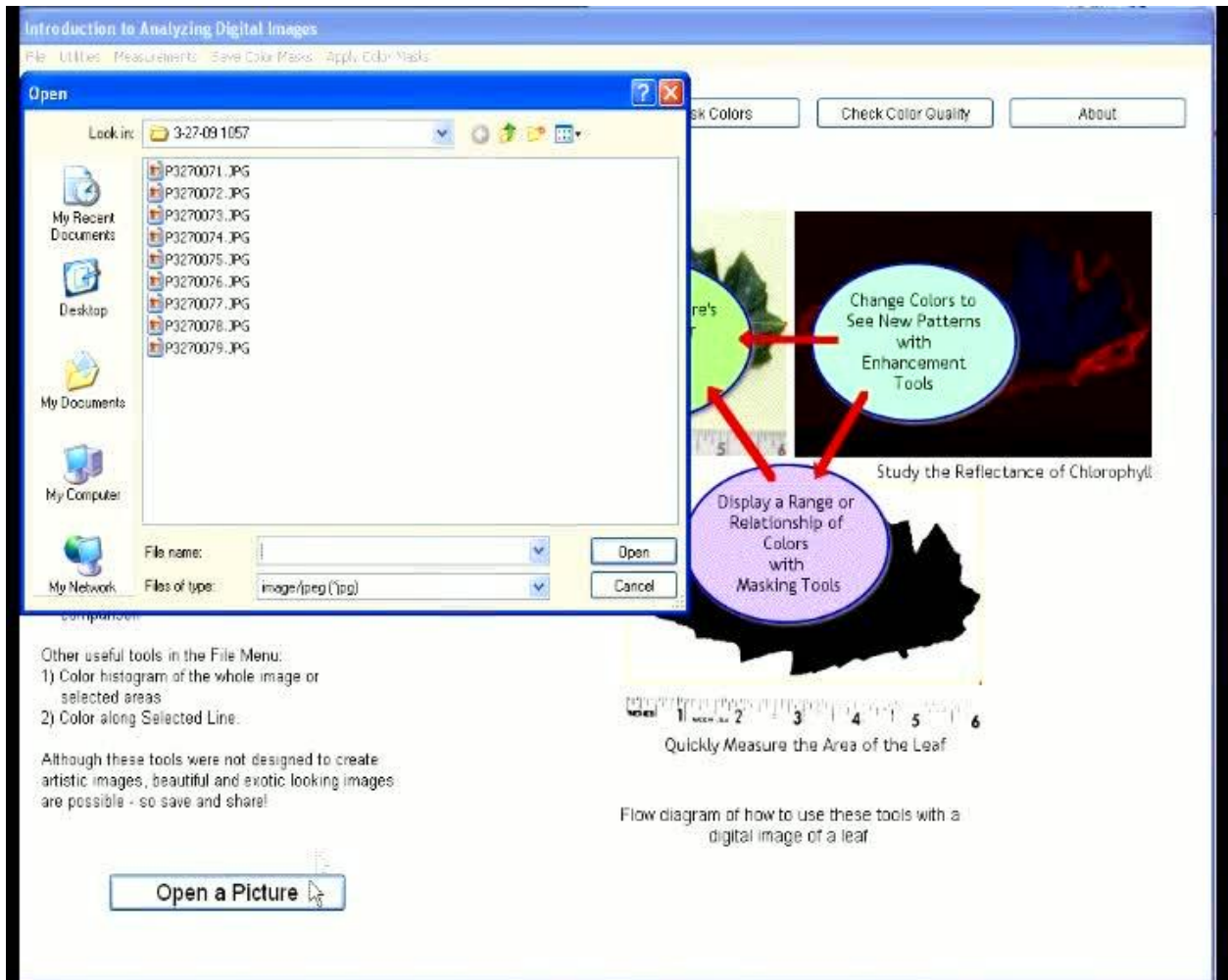
These pictures are also then uploaded to the Picture Post website where they are collected for use in scientific research.





picture post

DEW Software Tutorial Part 1

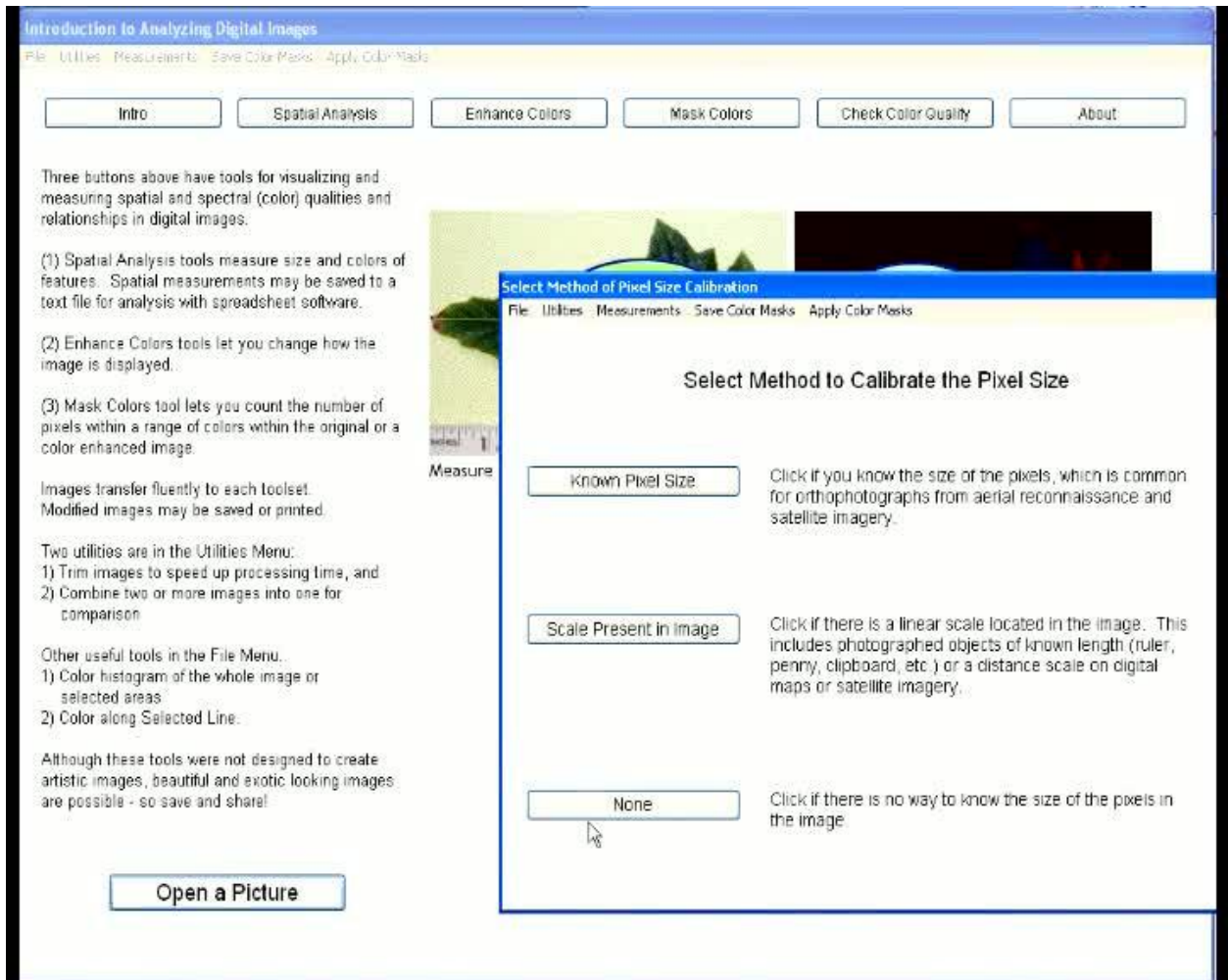


Hi there, and welcome to the first digital Earth Watch Software Tutorial.

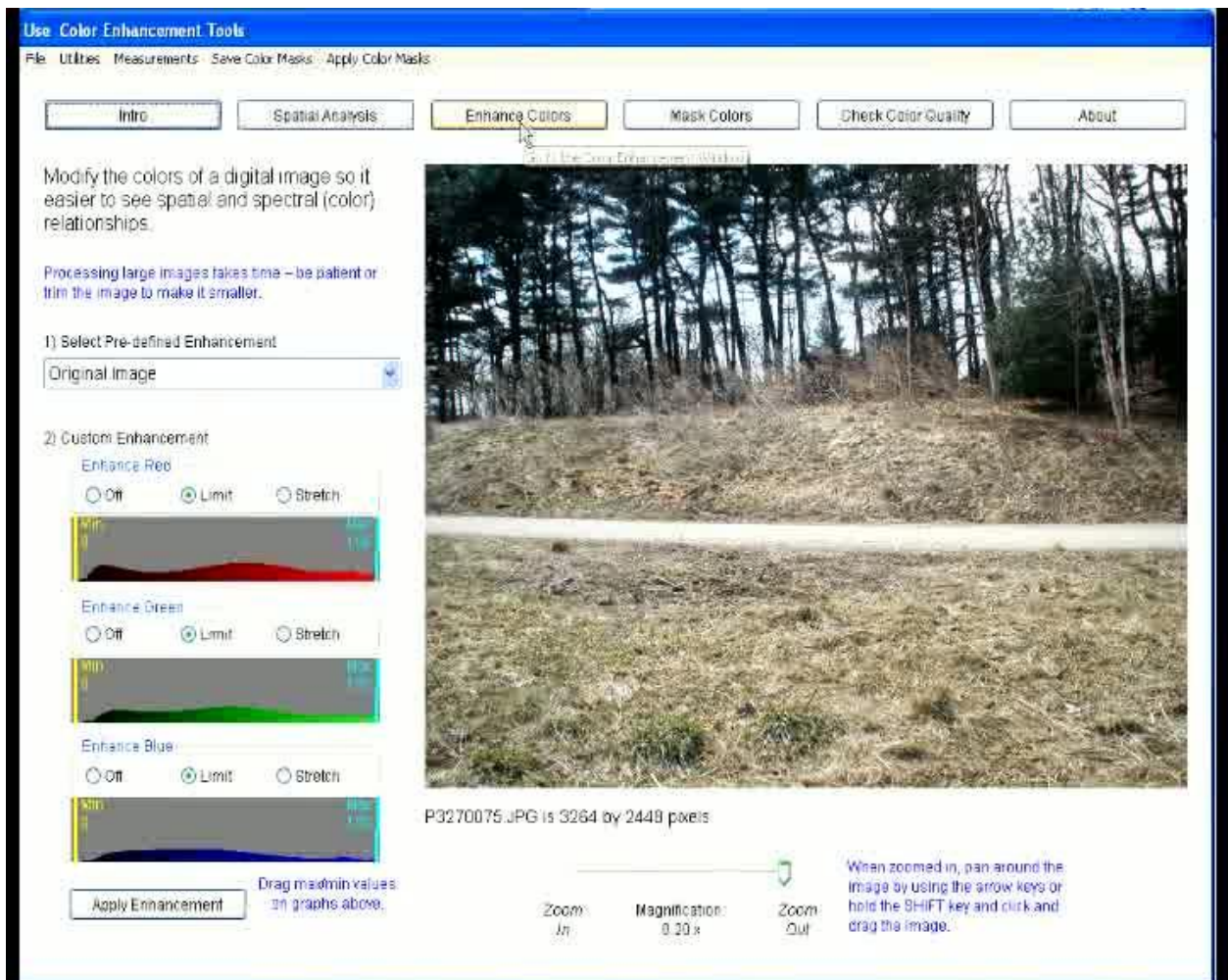
In this Tutorial you will learn how to quantify the green color in a picture to calculate a relative percent biomass.

As a warning beforehand some of these processes can be slow so if you are following along on your own opportunities to pause the video will appear, take this time to allow your computer to complete the task.

First open up the target picture using the open a Picture button, selecting none for the pixel scale.



Select none for the pixel scale.



Next, press the enhance colors button to move to the Enhance Colors page.

From the drop-down menu on the left select Red vs. Green (Normalized).

Use Color Enhancement Tools

File Utilities Measurements Save Color Masks Apply Color Masks

Intro Spatial Analysis Enhance Colors Mask Colors Check Color Quality About

Modify the colors of a digital image so it is easier to see spatial and spectral (color) relationships.

Processing large images takes time – be patient or trim the image to make it smaller.

1) Select Pre-defined Enhancement

Original Image

- Original Image
- Gray Image of Red Intensities
- Gray Image of Green Intensities
- Gray Image of Blue Intensities
- Gray Image of Average Intensities
- Red vs Green (normalized)**
- Red vs Blue (normalized)
- Green vs Blue (normalized)

Enhance Green


Off Limit Stretch

Enhance Blue

Off Limit Stretch

Apply Enhancement

Drag min/max values on graphs above.



P3270075.JPG is 3264 by 2448 pixels

Zoom In Magnification: 0.20 x Zoom Out

When zoomed in, pan around the image by using the arrow keys or hold the SHIFT key and click and drag the image.

From the drop-down menu on the left select Red vs. Green (Normalized).

Use Masking Tools to Analyze Color and Size of Features

File Utilities Measurements Save Color Masks Apply Color Masks

Intro Spatial Analysis Enhance Colors Mask Colors Check Color Quality About

Two types of color TESTS generate black and white results: Black pixels passed the color tests, white did not.

The resulting black and white image is called a mask, and may be used with the "area" spatial tools (rectangle and polygon) to measure areas of features that have been isolated from surroundings with the color tests.

Select Image to Mask

Original Enhanced

TEST 1 Magnitude of colors.
Select range of color intensities.
Pixels with colors in these ranges are made black.

Red Min: 0 Max: 255

Green Min: 26 Max: 255

Blue Min: 0 Max: 255

Apply Mask-TEST 1 Drag max/min values on graphs above or drag area on digital image.

Create TEST 2 Relationship Mask

Test the relationships between colors. For example, highlight pixels that have blue intensities at least twice as great as red values.

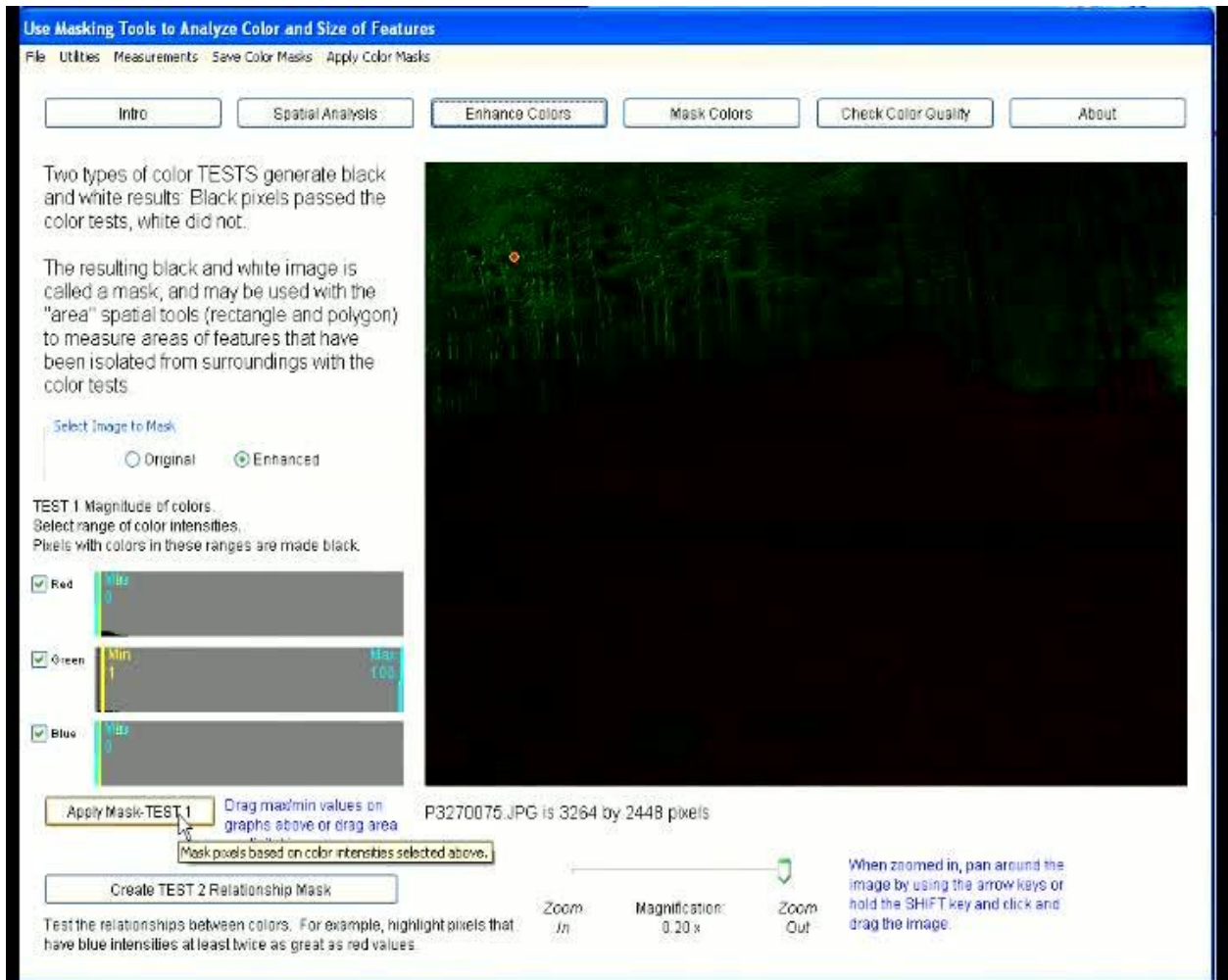
P3270075.JPG is 3264 by 2448 pixels

Zoom In Magnification: 0.20 x Zoom Out

When zoomed in, pan around the image by using the arrow keys or hold the SHIFT key and click and drag the image.

Once the Picture appears, select the Masking Colors tool at the top.

On this page you can click on one of the green pixels in the picture to get a sample of the green colors in the picture.



Make sure that the red and blue spectrums are positioned at a minimum and maximum of 0.

Then, slide the green to a minimum of one and a maximum of 100 and press the Apply Mask Test-1 button.

The Masking Tools to Analyze Color and Size of Features

File Edit Measure View Color Masking Help

Intro Spatial Analysis Enhance Colors Mask Colors Check Color Quality About


Two types of color TESTS generate black and white results: Black pixels passed the color tests, white did not.


The resulting black and white image is called a mask, and may be used with the "area" spatial tools (rectangle and polygon) to measure areas of features that have been isolated from surroundings with the color tests.


Select Image to Mask

Original Enhanced

TEST 1 Magnitude of colors.
Select range of color intensities
Pixels with colors in these ranges are made black.

Red 


Green 

Blue 

Show Mask Drag max/min values on graphs above or drag area on digital image.

Create TEST 2 Relationship Mask

Test the relationships between colors. For example, highlight pixels that have blue intensities at least twice as great as red values.

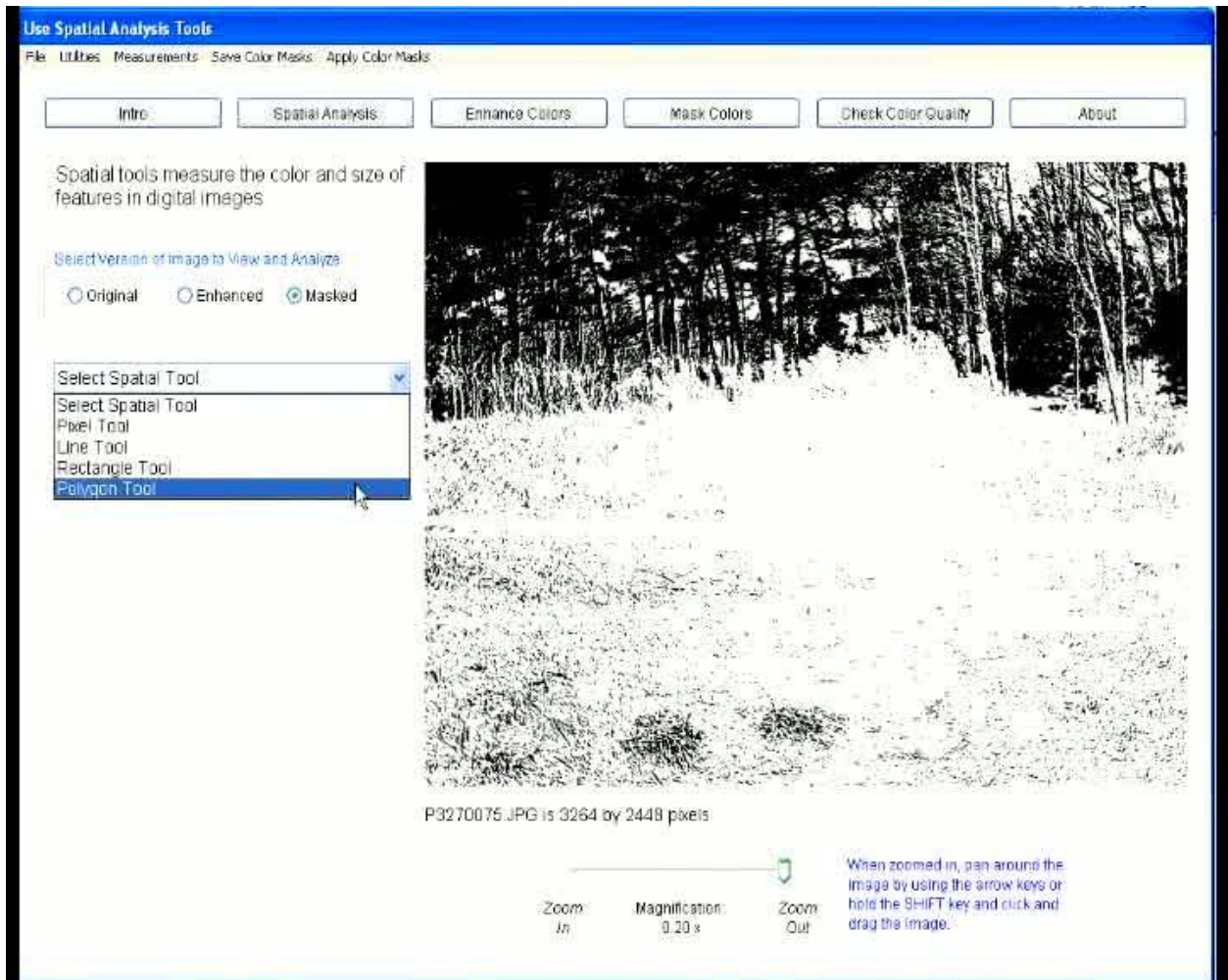


P3270076.JPG is 3264 by 2448 pixels

Zoom In Magnification: 0.20 x Zoom Out

When zoomed in, pan around the image by using the arrow keys or hold the SHIFT key and click and drag the image.

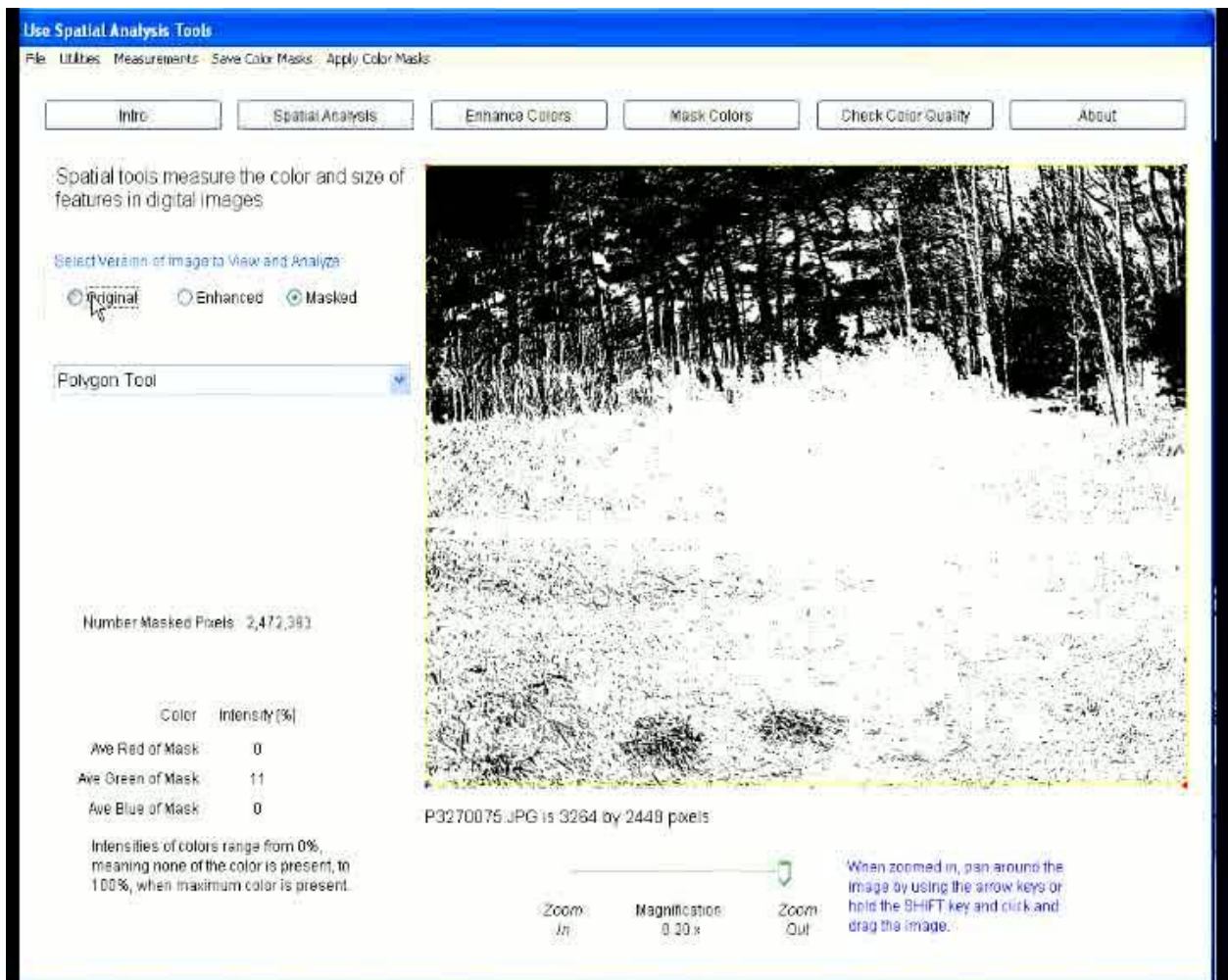
Once this mask is applied you will see an image that is mostly white with black in the areas where the picture is green.



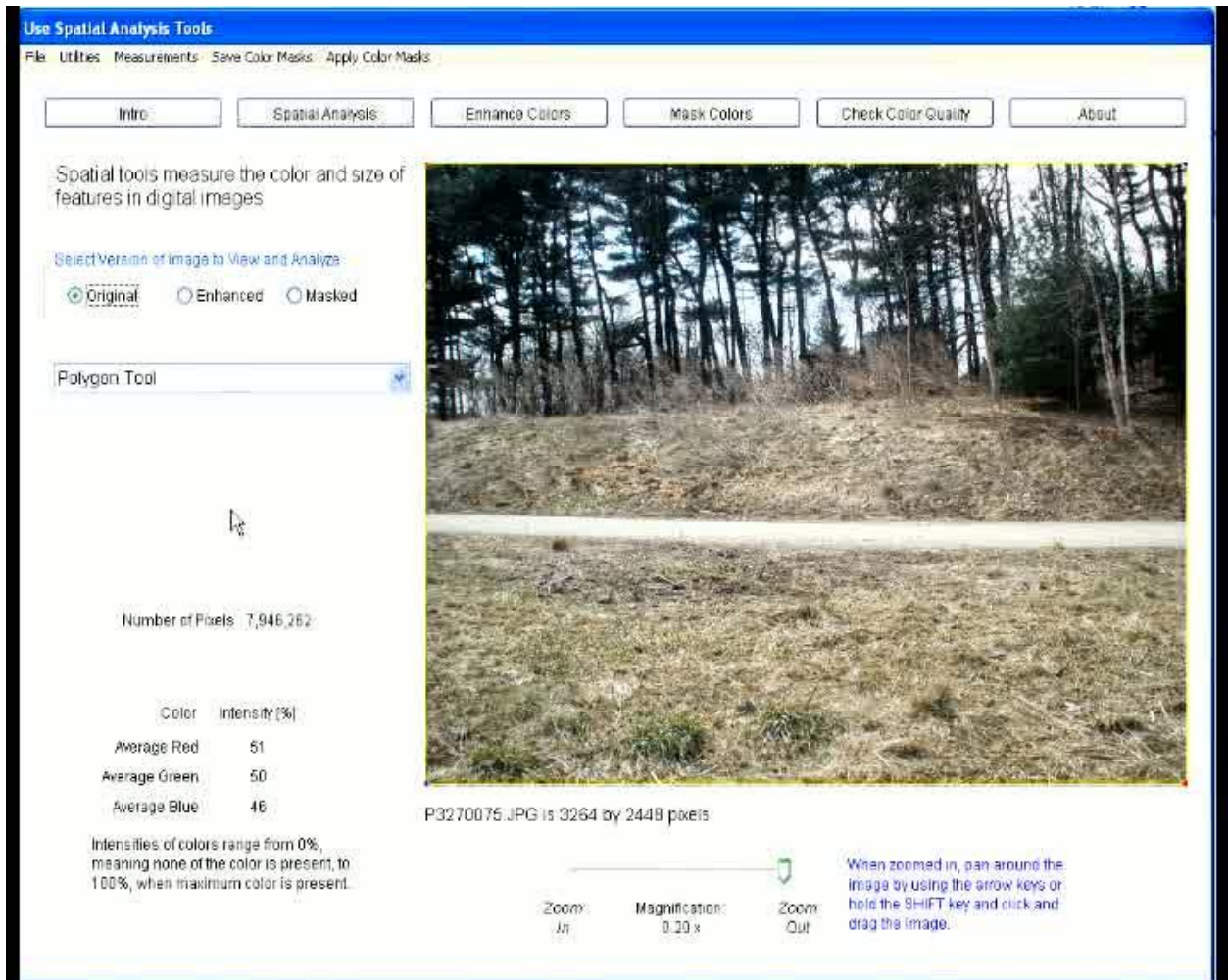
From here, move to the Spatial Analysis page by pressing the button at the top of the page.

On this page, select the Polygon tool from the drop-down menu on the left.

Drag the first point into one corner and continue clockwise around until you return to the first corner.



The Program will display a number of masked pixels.



At the top, select the option to display the original picture; the number displayed will then be the total pixels in the selected area.

By dividing the number of masked pixels by the total, a percent of masked pixels in the picture is calculated.

This number is representative of the overall biomass of the vegetation in the picture. You can now repeat this process in order to track the change in biomass over time for a given orientation from a Picture Post.

5.3. Publications

5.3.1 Picture Post Directions



picture post

Directions

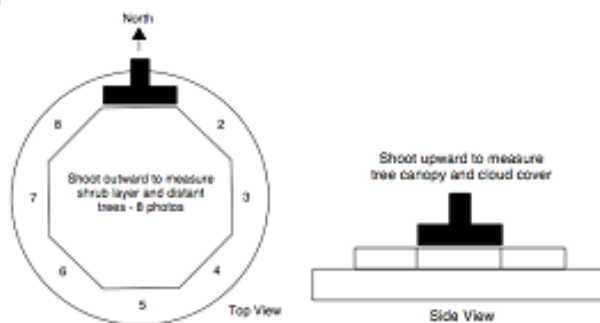
Take out your camera and align it along the North edge of the protruding octagon.

Make sure that the camera is zoomed all the way out and is set to your camera's default picture mode.

Center the camera on the North edge and take your first Picture Post picture.

Continue taking pictures clockwise on each side of the octagon until you have taken a picture in each of the eight directions.

Finally take a picture straight up to capture the vegetative canopy and current weather conditions.



Upload Directions

To upload your pictures go to:
www.picturepost.unh.edu

Once there, follow the site directions to share, critique, and help citizens scientists everywhere monitor local climate change!

5.3.2 Picture Post Park Posters



picture post

At Fresh Pond Reservation

What is a picture post?

An environmentally friendly post allowing panoramic pictures to be taken in exact locations over a period of time. These images can provide users with the ability to monitor short and long term environmental change of the local area.

Onsite directions are provided at each post location to further assist in the picture post process.

Who can I contact?
 J. Rogers, Chief Ranger
 617 349-4793
 jrogers@CambridgeMA.GOV

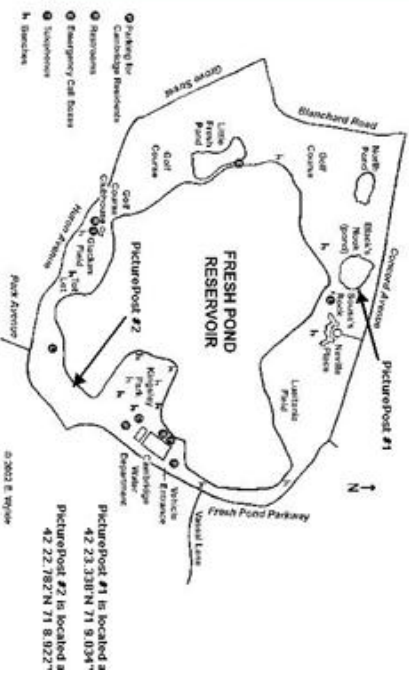
How does it work?

The picture post has a platform that is simply an octagon placed in the center of a flat surface and secured to a post. Photographs are taken with the camera placed on the flat surface with the back of the camera centered on an edge of the octagon. Eight pictures are taken, starting with the camera pointing north and progressing clockwise. A ninth picture is taken with the back of the camera placed on the octagon with the lens pointing skyward to capture vegetative canopy and current weather.



Where are they located?

FRESH POND RESERVATION
 CAMBRIDGE, MASSACHUSETTS





picture post

At Menotomy Rocks Park

What is a picture post?

An environmentally friendly post allowing panoramic pictures to be taken in exact locations over a period of time.

These images can provide users with the ability to monitor short and long term environmental change of the local area.

Onsite directions are provided at each post location to further assist in the picture post process.

Who can I contact?

John Pickle
picklejohnm@gmail.com
781-266-6671

How does it work?

The picture post has a platform that is simply an octagon placed in the center of a flat surface and secured to a post.

Photographs are taken with the camera placed on the flat surface with the back of the camera centered on an edge of the octagon.

Eight pictures are taken, starting with the camera pointing north and progressing clockwise.

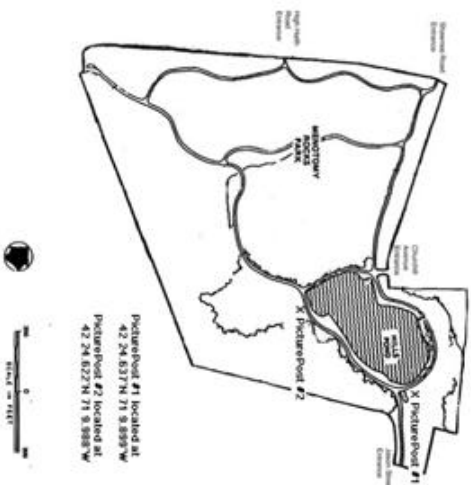
A ninth picture is taken with the back of the camera placed on the octagon with the lens pointing skyward to capture vegetative canopy and current weather conditions.



Where are they located?



Measuring
Vegetation
Health



8. References

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