# IQP:
# Photographic Documentation of the Cromwell Brook Watershed

*An Interactive Qualifying Project submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science*

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## Abstract

Watersheds are regional hydrological systems that are shaped by their local geography. These systems are particularly vulnerable to change, especially when they are located near developed areas. Within Acadia National Park, the Cromwell Brook Watershed is experiencing several changes that could affect the health of the area. To help address these potential issues, designated problem areas were documented utilizing photographic and sonic techniques. This documentation constructs a baseline for future comparison, allowing researchers to determine what is impacting the watershed. Evidence gathered can then aid in future restoration actions to maintain the ecological health of the Cromwell Brook Watershed.

## Executive Summary

Acadia National Park, like most national parks, is experiencing change. Whether this results from climate change, pollution, or other factors, the park seeks to understand what is occurring. The park wishes to monitor certain areas of Acadia to track such changes. Specifically, the Cromwell Brook Watershed is an area of importance to the park service. This is due to its vital role in the local hydrology near Bar Harbor. No work has previously been done to thoroughly document the area and its environmental issues. The first goal of this project was to fill in this information gap with extensive photography and noise level measurements.

From June 16th to August 1st, 45 sites were visited in the watershed area and documented through photography. The sites were selected based on a map provided by Acadia National Park's GIS and Resource Management staff as potential problem areas.

Noise level measurements were performed at two locations in the watershed for five days at a time. The average and maximum noise levels, as well as frequency data, were collected over the recording period. Sites were chosen based on communication with Acadia National Park as well as the sites' predicted quietness.

The second goal of documenting through these mediums was to facilitate the use of repeat measurements, such as repeat photography. These reproductions will enable analysis of ongoing ecological changes within the watershed so conservation efforts may be accurately deployed. The practice of repeat photography has been historically ambiguous in its methodologies. For this project, numerous measurements were taken at each documentation site. GPS coordinates, setup photographs, date and time, compass bearings, and other factors were indexed in a database along with photographs and noise level recordings. In doing so, this project

has set a standard in methodology for much simpler use of repeat methods, especially repeat photography.

Annual reproduction of this project is vital to conservation efforts in the Cromwell Brook Watershed. This will allow more accurate tracking of changes in the watershed compared to repeat documentation between greater periods of time. This project not only benefits the future of the watershed, but also serves as an important model for future documentation efforts. Expanding this work will ultimately lead to better conservation efforts within Acadia National Park.

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## Chapter 1: Introduction

The National Park Service has two goals: to protect the natural environment and to make it accessible. Two of the difficulties in accomplishing these goals are rapid environmental change and pollution. Environmental changes affect ecosystems through warming temperatures, large rainfall, and loss of native species. The current project will create a photographic baseline for future work in repeat photography. Repeat photography is the practice of reproducing photographs over a period of time. These reproductions will allow scientists to note any ecological changes within the watershed. Repeat photography has typically been a poorly defined practice. The database built will allow Acadia National Park to more accurately track and address ecological changes.

The park is currently focusing on improving the resilience of Mount Desert Island's natural areas. The health of areas such as forests, wetlands, and watersheds contributes to the overall condition of the region. Watersheds in particular are environmentally significant because of their role in the hydrologic system. If a watershed does not function properly, it can damage the water quality and ecological well-being of an area.

Stretching from Dorr Mountain to Bar Harbor, the Cromwell Brook Watershed is particularly endangered. One of the oldest parts of Acadia National Park, it receives numerous visitors annually. Due to its popularity, there have been considerable efforts to improve the area's accessibility. However, little is known about how this attention affects the ecological health of the watershed. Negative phenomena have been documented in the watershed; however empirical data remains sparse.

The lack of data makes it difficult to assess the impact of ecological changes in the area. A baseline to use for comparison is essential for drawing accurate conclusions about future

ecological impacts. The project created a database of photographic recordings, as well as exploratory noise level work. The photographs were high quality and covered diverse sections of the watershed.

# Chapter 2: Literature Review

This chapter presents an overview of the literature surrounding watersheds, ecological baselines, and the establishment of visual and audio baselines related to them. An ecological baseline is a multi-faceted measurement and benefits from multiple forms of recording. Therefore, the role of visual and audio information in creating a baseline will be covered.

## Section 2.1 Watersheds

Watersheds are networks and systems that play vital roles in their respective environments. Watersheds are regions where multiple natural water sources drain into a single body of water (Miller-Rushing, Cole-Will, Mansk, 2014). These regions house local flora and fauna populations, influence water quality, and help cycle nutrients (Miller-Rushing, Cole-Will, Mansk, 2014; Lal, 2014). Because the size of the drainage system can vary depending on the local topography, watersheds range from large networks of waterways to single brook systems (Lal, 2014).

Watersheds are especially at risk from climate change. Increased rainfall, caused by increased air temperature, can result in soil erosion and flooding. Soil erosion transports nutrients, soil, and chemicals downstream in the form of run off or increased leaching. The removal of nutrients and soil can cause land loss and soil quality degradation (Ritter & Shirmohammadi, 2010). The flooding of watersheds near human developments can cause accidental water pollution (Miller-Rushing, Cole-Will, Mansk, 2014). Pollution can also come from the addition of nutrients. Phosphates for example, a common component of many laundry detergents until the 1980s, can lead to algal blooms and eutrophication of water sources. (Knud-Hansen, 1994)

A watershed of particular concern to Acadia National Park is the Cromwell Brook Watershed. The Cromwell Watershed is located in the Northeastern area of Mount Desert Island and just South of Bar Harbor. The watershed receives an average of 109 inches of precipitation annually, 48 inches of rain and 61 inches of snow (Kaiser, 2010). This water flows down from Dorr Mountain and Champlain Mountain into the Tarn, a small pond between the two mountains. The water then runs into Cromwell Brook and out into the Atlantic Ocean. This hydrological system is vital for the area's flora and fauna. Red spruce, birch, and oak trees as well as beavers, raccoons, porcupines, fox, deer, and rabbits inhabit the area's boreal forest (Kaiser, 2010). In order to protect the local wildlife and the area, it is important to know its current ecological state. Establishing a baseline is the first step in accomplishing this.

Picture of the Cromwell Brook Watershed

## Section 2.2 Establishing an Ecological Baseline

Ecological baselines can take multiple forms depending on the methods used. They can be centered on biogeochemical, wildlife diversity, geological, and energy surveys. These baselines can help determine the extent of change, such as damage, done to a site over time

(Burger, Gochfield, Powers, and Greenberg, 2007). This knowledge is essential for organizing restoration and preservation efforts in damaged areas.

Damage can be caused by human influence, especially in non-protected sites. Thus, when human factors are present, it is important to measure changes in the specified site over time. This can be done through the use of retrospective analysis. Retrospective analysis involves comparing current measurements to previous measurements. Disparities between the two sets can reveal changes in the environment. The use of retrospective analyses in combination with comprehensive measurements allows for accurate assessment of changes in a site's environmental health (Burger, Gochfield, Powers, and Greenberg, 2007).

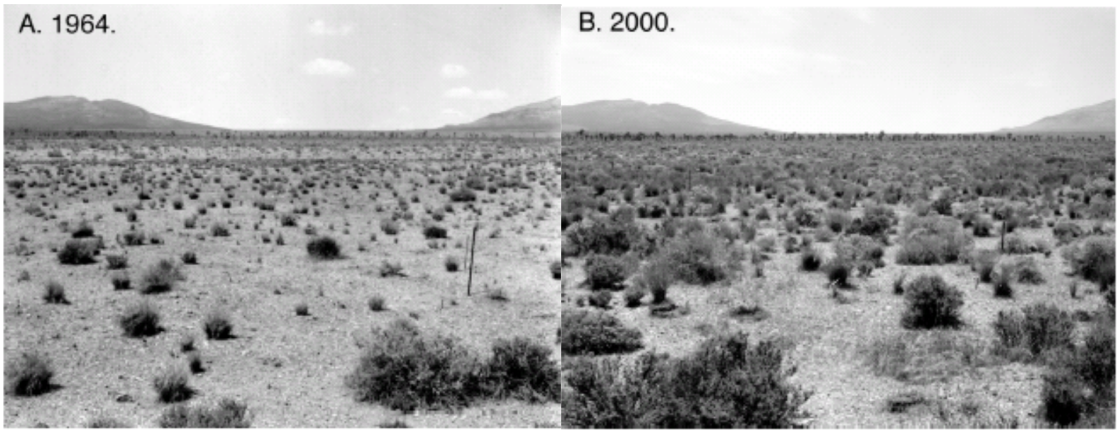
The type of measurements chosen are important in determining the usefulness of a baseline. The results must be of a kind that can be used to draw useful conclusions. Visual and audio recordings are two of the most accessible measurements.

### Section 2.2.1 Visual Measurements

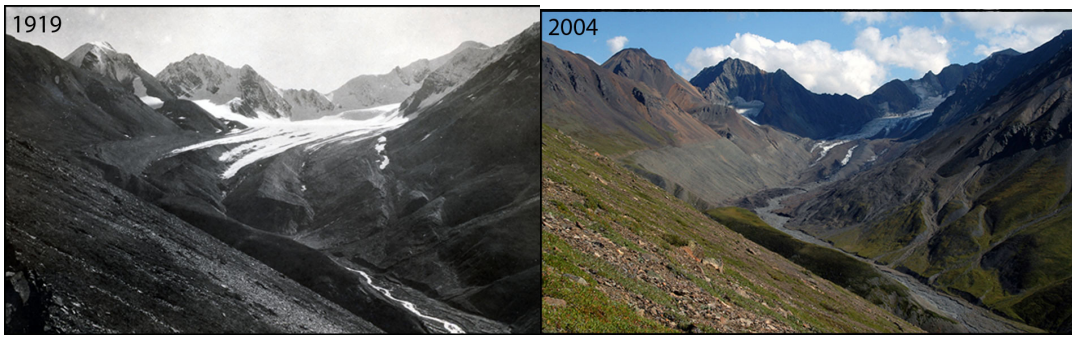
Visual measurements are indispensable for documenting an area. These measurements are the most readily understood indications of ecological health. By directly observing changes over time, the condition of an area can be determined. Extensive photography can be used to achieve this visual documentation, creating a starting point for future use of repeat photography. Repeat photography is the practice of repeating photographs of the same area to visually note changes over time (Klett, 2011).

Repeat photography has been used since as early as 1888. Bavarian mathematician Sebastian Finsterwalder, using the same camera stations, took multiple years' worth of

photographic surveys of mountain glaciers. He then compared photos from different years to document change in the glaciers. (Webb, 2010)




Repeat Photography in Mojabi Desert, Nevada (Webb, Robert H. 2014)




Repeat Photography in Denali National Park, Alaska (Capp 1919)

Repeat photography proved useful for documenting glacial change, and came to be used in other environments. In a desert environment south of Tucson, repeat photography was used from 1903 to 1913. The resulting photos showed a decline in rangeland species over the years measured. Researchers found repeat photography to be useful in a variety of environments and it has since become more widely used. In the last few decades, hundreds of published research projects have utilized repeat photography. (Webb, 2010)

Repeat photography serves as a very useful tool in restoration ecology. This is defined as the practice of renewing degraded or destroyed ecosystems by active human intervention. In

order to beneficially intervene, current ecological status and occurring changes must be known. Analysis of the photographic data gathered can be used to visually assess such changes. This allows for preservation efforts to be directed at observable changes (Byers, 1987).

Although examples of repeat photography are numerous, there are no strict protocols for conducting it. Repeat photography is more a concept than a procedure and must be implemented on a case by case basis. There are, however, requirements that must be met in performing repeat photography. These include precise documentation of all factors involved the camera's location and settings and consistency of recording techniques. (Webb, 2010)

### Section 2.2.2 Audio Measurements

Another way to determine the health of an area is by measuring noise levels. Scientists have been doing this for nearly a century. The Cornell Lab of Ornithology, founded in 1915, records many animal sounds, particularly bird calls and songs. The lab has used this data to build the world's largest archive of natural sounds. They use this data to learn about the health of ecosystems. (Cornell Lab of Ornithology, 2015)

While less obvious than visual elements, the soundscape of an area can indicate its vitality. (Flatow, 2011) To observe the acoustic changes in a watershed over time, recording noise levels is essential. This enables researchers to ascertain the impact of noise pollution.

This less-intuitive form of pollution has been a problem for centuries. (Goines and Hagler, 1999) It interferes with healthy sleep patterns, acts as a barrier to spoken communication, leads to hearing impairment, and influences mental health. (Suter, 1991) All this negatively affects one's ability to work, as well as increasing irritability and decreasing sociability.

Noise pollution not only affects humans, it impacts wildlife. Many animals use unique calls to communicate with each other. Vervet monkeys, for example, announce danger through calls (Seyfarth, 1979) and roosters communicate the quality of food to hens. (Marler et al., 1986) Without the ability to communicate, animals would have difficulty cooperating and surviving.

This communication has become difficult in settled areas as humans have quickly created an overwhelming amount of noise. Some species cannot adapt fast enough, and their reproductive success suffers (Warren, 2006). Speciation can also move faster as different populations become isolated based on their diverging calls (Rabin and Greene, 2002). If the population is small, this can lead to its extinction.

Noise levels can also influence the habitability of areas; excessive noise can render certain areas inhospitable for less flexible species. (Reijnen and Foppen, 1994) This leads to reduced species richness. (Francis et al., 2009) Environmental noise can even negatively affect animals on the genetic level. (Kight and Swaddle, 2011)

All of this can severely impact the health of an ecosystem, affecting food chains and nutrient cycles. To maintain an area, it is therefore essential to understand how noise levels change from year to year. This knowledge allows researchers to determine what conservation work needs to be done to preserve the ecosystem's vitality.

### Section 2.2.3 Measurements in Cromwell Brook Watershed

The use of both photographs and audio measurements allowed the created baseline to be both accessible and comprehensive. By involving different forms of data, the baseline is widely useable rather than limited to a single form of measurement. Additionally, photo and audio measurements were specifically requested by Acadia staff. This project addressed gaps in the

National Park's data about the watershed. (A. Miller-Rushing, personal communication, April 2015)

# Chapter 3: Methodology

This chapter will begin by examining the selection of documentation sites. The methods for performing photographic and audio documentation will also be covered. Finally, equipment selection will be discussed.

## Section 3.1 Site Selection

The Cromwell Brook Watershed stretches from "Dorr Mountain and the Tarn, through the Sieur de Monts and Great Meadow area, and into Cromwell Cove in Bar Harbor." (Miller-Rushing, Cole-Will, Mansk, 2014) Documenting every corner of the watershed is beyond the scope of this project. Acadia National Park has therefore identified several key sites along the Cromwell Brook and the Tarn. A map containing these sites, or photopoints, and information about their environmental issues guided documentation of the area. *(See Figure 1 in the Appendix for an enlarged version)*

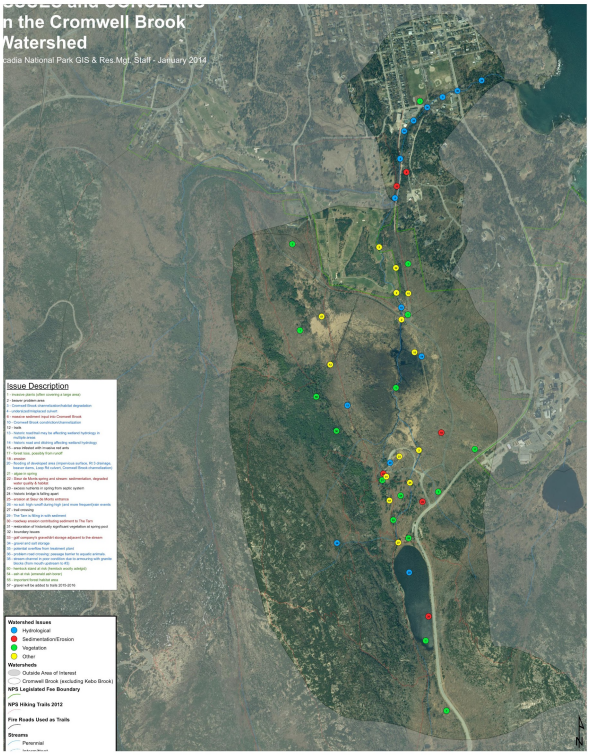



*Figure 1* shows the map provided by Acadia National Park of the Cromwell Brook Watershed boundaries with noted points of ecological concern.

Further communication with Acadia National Park led to the removal of most of the invasive species sites from the project's photopoint collection, as the Park's invasive species team resolved many of the issues. A couple sites were also added to the project: an old river intersection and a stand of trees suffering beech bark disease.

Working with park staff also helped determine the locations for noise level recording. Quiet sites were chosen so future research groups could monitor more apparent changes in noise level. Two locations were used: off the trail on Huguenot Head and off Jesup Path in the Great Meadow. Issues with the battery (*See Sections 4.4 and 6.4 for more information)* prevented recording at additional sites.

## Section 3.2 Photographic Methods

Due to the lack of a strict protocol in the literature, it was necessary to establish a concrete procedure for photographic documentation. A variety of shots were taken at each site to capture a wide range of qualities. This will facilitate comprehensive analysis in future use of repeat photography.

Exact replication of photographs depends on a variety of factors. For each photograph taken, 13 measurements were recorded: date, time, GPS coordinates, photo location, photo filename, type, compass azimuth, tripod height, lead leg length, back legs length, camera zoom, weather, and description. (*See Figure 2 in the Appendix for a table format of these)*

Each of the factors was documented by hand for each photograph taken. The camera was typically horizontally leveled using the tripod's built-in level as well as the camera's built-in level (accessed by cycling through the display options). When the camera was vertically angled to capture a point, the lengths of the tripod legs were recorded in addition to the tripod height.

Several indexes were created and updated each day with the data and photographs collected. Indexes of all the photographs, one organized chronologically and another by photopoint, were made in Google Sheets. The filenames of the photographs, which were uploaded to Google Drive for safe storage, were matched with the handwritten data and logged in the spreadsheet.

Additionally, pictures were taken of each photography setup and logged in site indexes, again one organized by date and the other by photopoint. A master list of all photopoints was also generated so progress could easily be tracked.

| Date | Time | GPS | Photo Location | Site Photo Filename | Associated Photo Filenames |
|---|---|---|---|---|---|
| 6/16/15 | 1:45-1:52 | 42 21' 46" N<br>68 12' 21" W | 2 | 726.JPG | P1000044.JPG |
| | | | | 726.JPG | P1000045.JPG |

Data table example for setup photos

| Photopoint | Status | Notes | Complete | Uncertain |
|---|---|---|---|---|
| 1 (In The Tarn) | Complete | | 38 | 2 |
| 1 (Near Route 3) | Don't worry | Invasive species team took care of this | | |
| 1 (Near Town Tennis Courts) | Complete | | **Not Done** | **Don't Worry** |
| 1 (Near Jesup Path) | Don't worry | Invasive species team took care of this | 2 | 8 |
| 1 (Immediately South of The Tarn) | Don't worry | Invasive species team took care of this | | |
| 1 (Wicked South of The Tarn) | Don't worry | Invasive species team took care of this | Updated for 7/6 | |
| 1 (Middle of the Great Meadow) | Don't worry | Invasive species team took care of this | | |
| 1 (Near Point 2 in Great Meadow, 10) | Don't worry | Invasive species team took care of this | | |
| 1 (Near 15 in Great Meadow Loop Trail) | Don't worry | Invasive species team took care of this | | |
| 2 (In Great Meadow, Near Park Loop Road) | Complete | | | |
| 2 (Near Sieur De Monts) | Complete | | | |
| 2 (North of Point 32) | Complete | | | |
| 2 (South of Point 32) | Complete | | | |
| 3 | Complete | | | |
| 4 (Near Golf Course Gravel Storage) | Complete | | | |
| 4 (North of Point 6) | Complete | | | |
| 6 | Complete | | | |
| 10 | Complete | | | |
| 12 | Complete | | | |
| 13 | Uncertain | Hydrology, needs clarification | | |
| 14 | Complete | | | |
| 15 (Near Point 14) | Complete | | | |
| 15 (Great Meadow Loop Trail) | Complete | | | |
| 17 | Complete | | | |
| 18 | Complete | | | |

Photopoint master list example

## Section 3.3 Audial Methods

Audio documentation of areas consisted of noise level recordings. Two approaches to this were considered, each involving a trade-off between quality and quantity. One approach is to visit multiple sites and collect data for a small number of days. Alternatively, data can be collected over a longer period of time at a select few sites. For this project, the latter of the two methods was used. Because of the size of the watershed and the time available, this provided the best quality readings. GPS coordinates were also taken at each of the recording locations to facilitate reproducibility.

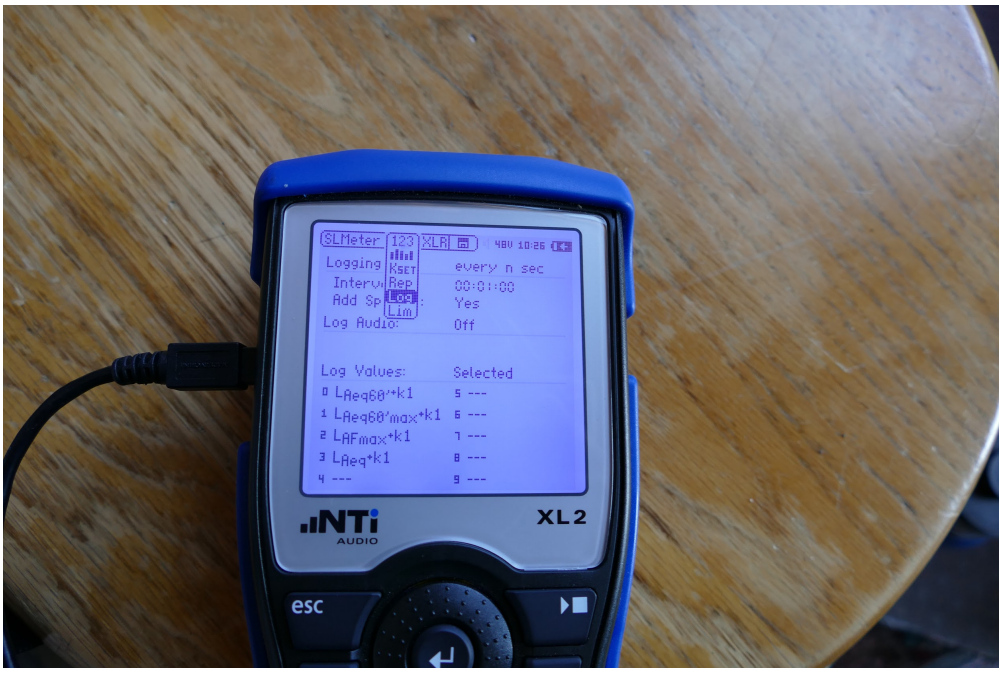
The NTI noise level recorder was placed inside of the modified Pelican case, sliding the attached M2230 microphone through the hole first. The Auray windscreen was then slid over the

M2230 microphone. The Pelican case was connected to the 12 volt car battery using the attached cables.

Pelican Case and Auray windscreen

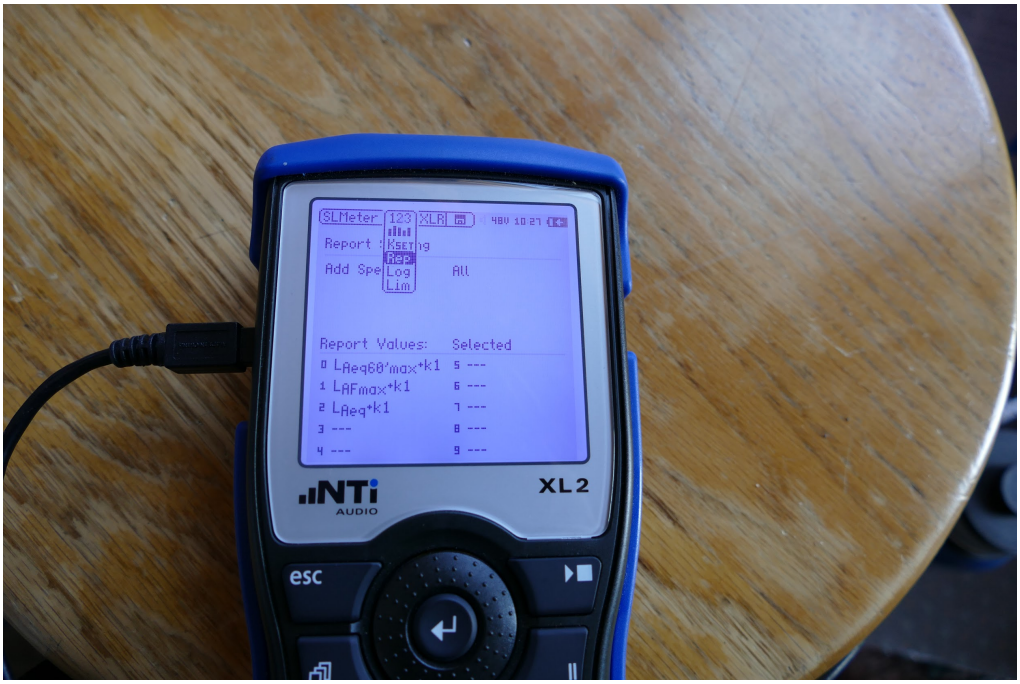
NTI XL2 recorder with M2230 microphone and 12 volt battery

The NTI was then turned on and activated to start collecting data. It is important that the proper settings be used so as to report the correct data. The code included uses the decibel level log and the frequency report. In order to generate these, one must first go to the “Log” tab on the NTI. Everything there should resemble the photo below. If “Add Spectra” is set to Yes, then a log of frequency recordings will be generated as well. This is not necessary with the code included here, but would be if trimming of bad data was desired.




Example of NTI Log settings

Next, one must go to the "Rep" tab. Everything there should resemble the photo below. Setting "Add Spectra" to All here will generate a frequency analysis report. This is necessary if such data is desired.




Example of NTI Report settings

The Pelican case was then closed. The car battery was placed inside of a plastic container to keep it safe from the rain. The Pelican case was then attached to a tripod using two bungee cords. The Pelican case was angled down slightly to discourage rain getting inside by running down the microphone. Towels covered the Pelican case and plastic container to muffle the noise of any rain hitting the units during recording.

Setup for the Great Meadow from 7/15/2015-7/20/2015

Once setup was complete, GPS coordinates were taken, the date and time were recorded, and the site was photographed. The device took measurements for fives days (120 hours). The battery life varies based on the recording settings. At the end of the five days, recording was stopped and the data saved. All equipment was then collected, the battery charged (approximately 12 hours) and redeployed in the next location.

*Please note: the NTI XL2 has a small battery pack that allows the unit to run for 4-5 hours. When this battery is placed in the unit, and the unit then connected to the external batteries, only the battery pack will be drained of power, it will not be charged by the external battery, and the unit will die when the battery pack runs out of charge. Remove this battery pack when setting the unit out to avoid power failures.*

*For a step-by-step procedure for extracting data from the NTI XL2, see Section 6.3 in the Appendix.*

## Section 3.4 Equipment Selection

Equipment should be of the highest possible quality within the constraints of the budget. Because photography and audio recording technology differ, requirements vary. A GPS is also necessary for documenting the location of each recording. Weather protection ensures the safety of the equipment.

### Section 3.4.1 Camera Selection

A good camera produces photographs with exquisite detail. In order to achieve this, the Lumix DMC FZ1000 was used. (*See Figure 14 in Appendix for camera specifications)* The Lumix DMC FZ1000 has the highest definition photos of cameras costing less than $1000. Additionally, it has a built-in panorama mode. The panorama mode allows one to take a continuous shot while rotating the camera, automatically producing a panoramic photo. This built-in feature eliminates the need for external photo stitching. In order to take photos that can create useable panoramas, stability is required. To accomplish this a Velbon Ex 330 tripod was used. As the project also required audio recordings, an audio recording device was necessary.

Lumix FZ-1000 camera

Velbon Ex 330 Tripod

## Section 3.4.2 Noise Level Recorder Selection

Sound levels, or measures of decibels over time, record the amount of sound in an area. To acquire this data, the NTI XL2 audio recorder was used. This piece of equipment has served admirably in previous projects. Use of an M2230 microphone extended the range of the NTI. The project captured sound levels in designated sites.

The NTI XL2 has a short battery life. This affects the ability to collect sufficient amounts of data. To overcome this limitation, two rechargeable 12 volt car batteries were used. Each provided approximately 120 hours of battery life to the NTI XL2, a major improvement over the stock 3-4 hours. (*See Sections 4.4 and 6.4 for more on the battery life)*

NTI XL2 recorder with M2230 microphone and 12 volt battery

## Section 3.4.3 GPS Selection

Reproducibility is the key to repeat measurement and to producing a useful baseline. In order to promote reproducibility, each location must be accurately documented. One way of documenting a location is through GPS coordinates. GPS coordinates offer a consistent and repeatable measurement. Recording GPS coordinates at each site will allow future researchers to accurately and efficiently reproduce the recordings taken during this project. The Garmin eTrex H GPS was used to record the GPS coordinates at each photopoint and noise site. Previous project groups have found the unit durable and accurate

.

Garmin eTrex H Global Positioning System

## Section 3.4.4 Weather Protection

To capture data, the NTI XL2 must be left outside for an extended period of time. This leaves the device potentially exposed to inclement weather, and it cannot function unprotected in the rain. A Pelican Waterproof Case and an Auray WSF-2216-WP water-resistant windscreen protected the NTI XL2.

The Lumix FZ1000 is at risk when photographing during precipitation. To protect the device, a Vortex Media Storm Jacket was used during light rain.

Pelican Waterproof Case and Auray WSF-2216-WP Water Resistant Windscreen, respectively

Vortex Media Storm Jacket

### Section 3.4.5 Data Storage

A hard drive was used to store photographs and audio recordings in a consistent format. At the end of each day, all information was organised into directories with a master index to locate files. All data is considered the property of Acadia National Park. The NPS stored the data for future use. Additionally, all data is backed up on Google Drive in the event of hardware failure.

### Section 3.4.6 Miscellaneous Equipment

To measure compass heading, a standard issue U.S. military compass was used as it is durable and reliable. For the tripod height and leg lengths, a tape measure was used.

U.S. Military Issued Compass and Tape measure

### Section 3.4.7 Ethics

Methods adhered to standard procedures for protecting people and places. Confidentiality and anonymity was ensured for any persons involved. For photography, no point was photographed until it was clear of people. Non-destructive documentation was also used to keep the environment safe while measurements were taken.

*A timeline for the project can be found in the Appendix, labeled Figure 12.*

# Chapter 4: Results

Considerable data was collected while documenting the watershed; presenting the entirety of the resulting archive would be excessive. Only the essential, representative data for each photopoint will be provided. The data collected from the NTI XL2 will be presented in full.

## Section 4.1 Photopoint Documentation

Each photopoint has two representative photographs and all the data associated with them. This data is followed by the entries in the site index that ties the documentation of the photopoints to the photographs themselves. The photographs are then presented. All timestamped photographs document the camera setup for the associated pictures (some photographs use the same setup).

## Photopoint 1 (In The Tarn)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo file name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/25/2015 | 10:29 | 44 21' 25.8" N 68 12' 26.7" W | 44,357 | -68,207 | 1 | P1000257.JPG | single | 96 | 41.125 | N/a | N/a | 25 | sunny, clear | IMG_0956.JPG |
| 06/25/2015 | 10:32 | 44 21' 25.8" N 68 12' 26.7" W | 44,357 | -68,207 | 1 | P1000258.JPG | panoramic | 54-157 | 41.125 | N/a | N/a | 25 | sunny, clear | IMG_0956.JPG |

## Photopoint 1 (Near Town Tennis Courts)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/26/2015 | 10:31 | 44 22' 51.0" N 68 12' 20.1" W | 44,381 | -68,206 | 1 | P1000280.JPG | single | 264 | 41 | N/a | N/a | 110 | sunny, some clouds | IMG_1074.JPG (7/22/15) |
| 06/26/2015 | 10:36 | 44 22' 47.8" N 68 12' 18.1" W | 44,38 | -68,205 | 1 | P1000283.JPG | single | 297 | 28.625 | N/a | N/a | 53 | sunny, some clouds | IMG_0971.JPG |

## Photopoint 2 (In Great Meadow, Near Park Loop Road)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/22/2015 | 14:16 | 44 22' 10.1" N 68 12' 24.7" W | 44,369 | -68,207 | 2 | P1000217.JPG | single | 196 | 40.125 | N/a | N/a | 144 | sunny, clear, post-rain | IMG_0940.JPG |
| 06/22/2015 | 14:21 | 44 22' 10.3" N 68 12' 24.6" W | 44,37 | -68,207 | 2 | P1000219.JPG | single | 204 | 29.625 | N/a | N/a | 346 | sunny, clear, post-rain | IMG_0940.JPG |

## Photopoint 2 (Near Sieur de Monts)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/16/2015 | 13:45 | 44 21' 46.0" N 68 12' 21.0" W | 44,363 | -68,206 | 2 | P1000044.JPG | single | 110 | 41.9 | N/a | N/a | 25 | light rain, medium fog | 726.JPG |
| 06/16/2015 | 13:52 | 44 21' 46.0" N 68 12' 21.0" W | 44,363 | -68,206 | 2 | P1000045.JPG | panoramic | 55-200 | 41.9 | N/a | N/a | 25 | light rain, medium fog | 726.JPG |

## Photopoint 2 (North of Point 32)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/29/2015 | 12:33 | 44 22' 24.4" N 68 12' 28.0" W | 44,373 | -68,208 | 2 (north of 32) | P1000295.JPG | single | 228 | 34.125 | N/a | N/a | 25 | sunny, clear | IMG_0975.JPG |
| 06/29/2015 | 12:38 | 44 22' 22.9" N 68 12' 27.0" W | 44,373 | -68,208 | 2 (north of 32) | P1000296.JPG | single | 156 | 36.375 | N/a | N/a | 25 | sunny, clear | IMG_0976.JPG |

## Photopoint 2 (South of Point 32)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07/01/2015 | 13:45 | 44 22' 14.3" N 68 12' 24.6" W | 44,371 | -68,207 | 2 | P1000326.JPG | single | 250 | 42.5 | N/a | N/a | 25 | cloudy, pre-rain | IMG_0993.JPG |
| 07/01/2015 | 13:46 | 44 22' 14.3" N 68 12' 24.6" W | 44,371 | -68,207 | 2 | P1000327.JPG | single | 250 | 42.5 | N/a | N/a | 206 | cloudy, pre-rain | IMG_0993.JPG |

## Photopoint 3

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/26/2015 | 10:12 | 44 22' 52.5" N 68 12' 10.7" W | 44,381 | -68,203 | 3 | P1000274.JPG | single | 249 | 27 | N/a | N/a | 25 | sunny, some clouds | IMG_0969.JPG |
| 06/26/2015 | 10:49 | 44 22' 47.0" N 68 12' 20.0" W | 44,38 | -68,206 | 3 | P1000292.JPG | single | 125 | 26.75 | N/a | N/a | 25 | sunny, some clouds | IMG_0974.JPG |

## Photopoint 4 (Near Golf Course Gravel Storage)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/23/2015 | 10:54 | 44 22' 29.6" N 68 12' 26.4" W | 44,375 | -68,207 | 4 | P1000251.JPG | single | 19 | 35.25 | N/a | N/a | 65 | cloudy, pre-rain | IMG_0954.JPG |
| 06/23/2015 | 10:59 | 44 22' 30.2" N 68 12' 25.6" W | 44,375 | -68,207 | 4 | P1000255.JPG | single | 142 | 33.625 | 29.75 | 34(right) 29.375(left) | 50 | cloudy, pre-rain | IMG_0955.JPG |

## Photopoint 4 (North of Point 6)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/30/2015 | 10:21 | 44 22' 38.9" N 68 12' 23.7" W | 44,377 | -68,207 | 4 | P1000314.JPG | single | 201 | 27.49 | 28(R) 32.625( L) | 23.125 | 25 | sunny, some clouds | IMG_0985.JPG |
| 06/30/2015 | 10:33 | 44 22' 39.1" N 68 12' 23.2" W | 44,378 | -68,206 | 4 | P1000317.JPG | single | 351 | 35.375 | N/a | N/a | 170 | sunny, some clouds | IMG_0986.JPG |

## Photopoint 6

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/30/2015 | 10:35 | 44 22' 38.1" N 68 12' 23.1" W | 44,377 | -68,206 | 6 | P1000318.JPG | single | 100 | 35.125 | N/a | N/a | 25 | sunny, some clouds | IMG_0988.JPG |
| 06/30/2015 | 10:36 | 44 22' 38.1" N 68 12' 23.1" W | 44,377 | -68,206 | 6 | P1000319.JPG | panoramic | 45-125 | 35.125 | N/a | N/a | 25 | sunny, some clouds | IMG_0988.JPG |

## Photopoint 10

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/22/2015 | 13:58 | 44 22' 12.8" N 68 12' 23.8" W | 44,37 | -68,207 | 10 | P1000210.JPG | single | 170 | 29.75 | N/a | N/a | 25 | sunny, clear, post-rain | IMG_0932.JPG |
| 06/22/2015 | 14:09 | 44 22' 10.7" N 68 12' 24.3" W | 44,37 | -68,207 | 10 | P1000214.JPG | panoramic | 58-147 | 39.5 | N/a | N/a | 25 | sunny, clear, post-rain | IMG_0939.JPG |

## Photopoint 12

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/25/2015 | 12:07 | 44 22' 04.3" N 68 12' 41.5" W | 44,368 | -68,212 | 12 | P1000261.JPG | single | 46 | 42.125 | N/a | N/a | 25 | sunny, clear | IMG_0960.JPG |
| 06/25/2015 | 12:10 | 44 22' 04.9" N 68 12' 40.5" W | 44,368 | -68,211 | 12 | P1000262.JPG | single | 227 | 41.875 | N/a | N/a | 25 | sunny, clear | IMG_0961.JPG |

## Photopoint 13

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/22/2015 | 13:07 | 44 21' 52.9" N 68 12' 37.2" W | 44,365 | -68,21 | 13 | P1000205.JPG | single | 185 | 29.75" | N/a | N/a | 25 | sunny, clear, post-rain | IMG_0927.JPG |
| 06/22/2015 | 13:11 | 44 21' 52.4" N 68 12' 37.0" W | 44,365 | -68,21 | 13 | P1000206.JPG | single | 345 | 29.125 | N/a | N/a | 25 | sunny, clear, post-rain | IMG_0929.JPG |

## Photopoint 14

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07/06/2015 | 11:43 | 44 22' 04.9" N 68 12' 18.7" W | 44,368 | -68,205 | 14 | P1000334.JPG | single | 197 | 42.125 | N/a | N/a | 25 | sunny, some clouds | IMG_1044.JPG |
| 07/06/2015 | 11:46 | 44 22' 04.9" N 68 12' 18.7" W | 44,368 | -68,205 | 14 | P1000335.JPG | panoramic | 174-263 | 42.125 | N/a | N/a | 25 | sunny, some clouds | IMG_1044.JPG |

## Photopoint 15 (Great Meadow Loop Trail)

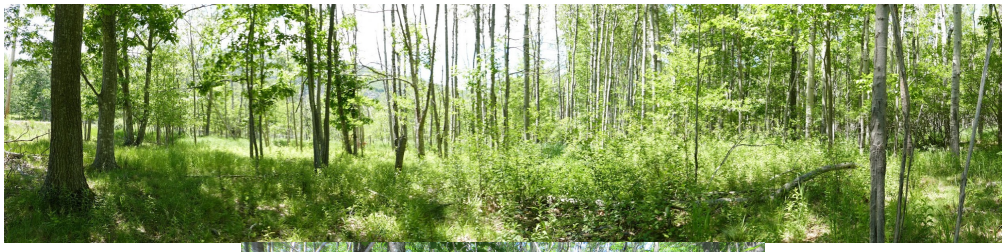
| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/23/2015 | 10:25 | 44 22' 18.8" N 68 12' 22.7" W | 44,372 | -68,206 | 15 | P1000242.JPG | multiple | N/a | freehand | N/a | N/a | N/a | cloudy, pre-rain | IMG_0951.JPG |
| 06/23/2015 | 10:25 | 44 22' 18.8" N 68 12' 22.7" W | 44,372 | -68,206 | 15 | P1000244.JPG | multiple | N/a | freehand | N/a | N/a | N/a | cloudy, pre-rain | IMG_0951.JPG |

## Photopoint 15 (Near Point 14)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07/06/2015 | 12:01 | 44 22' 04.9" N 68 12' 18.7" W | 44,368 | -68,205 | 15 (near 14) | P1000337.JPG | multiple | freehand | N/a | N/a | N/a | N/a | sunny, some clouds | IMG_1044.JPG |
| 07/06/2015 | 12:01 | 44 22' 04.9" N 68 12' 18.7" W | 44,368 | -68,205 | 15 (near 14) | P1000341.JPG | multiple | freehand | N/a | N/a | N/a | N/a | sunny, some clouds | IMG_1044.JPG |

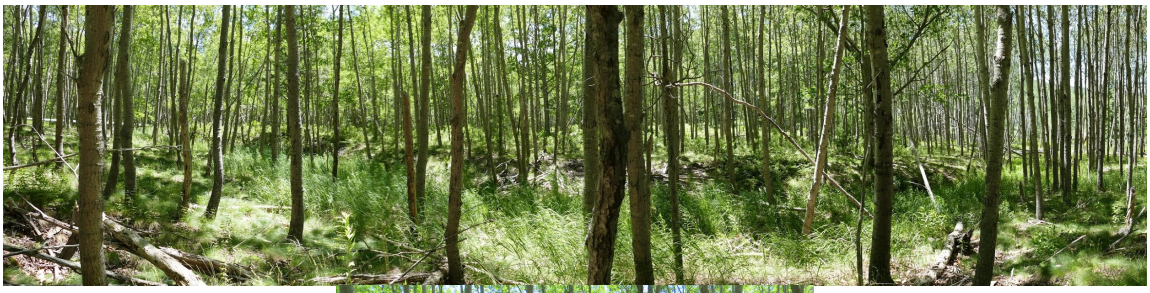
## Photopoint 17

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 13:39 | 44 21' 31.8" N 68 12' 37.1" W | 44,359 | -68,21 | 17 | P1000115.JPG | single | 66 | freehand | N/a | N/a | 99 | sunny, clear | IMG_0846.JPG |
| 06/18/2015 | 13:20 | 44 21' 47.7" N 68 12' 04.1" W | 44,363 | -68,201 | 17 | P1000136.JPG | panoramic | 242-21 | 39 | N/a | N/a | 25 | sunny, clear sky | IMG_0871.JPG |



## Photopoint 18

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/25/2015 | 12:47 | 44 21' 51.3" N 68 12' 14.7" W | 44,364 | -68,204 | 18 | P1000266.JPG | single | 164 | 40.125 | N/a | N/a | 25 | sunny, clear | IMG_0963.JPG |
| 06/25/2015 | 12:58 | 44 21' 52.5" N 68 12' 12.8" W | 44,365 | -68,204 | 18 | P1000272.JPG | panoramic | 167-284 | 38.75 | N/a | N/a | 25 | sunny, clear | IMG_0964.JPG |



## Photopoint 20

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07/01/2015 | 12:57 | 44 22' 43.4" N 68 12' 25.2" W | 44,379 | -68,207 | 20 | P1000322.JPG | single | 129 | 43.125 | N/a | N/a | 25 | cloudy, pre-rain | IMG_0990.JPG |
| 07/01/2015 | 13:10 | 44 21' 43.9" N 68 12' 27.3" W | 44,362 | -68,208 | 20 | P1000323.JPG | single | 154 | 40.625 | N/a | N/a | 25 | cloudy, pre-rain | IMG_0991.JPG |

## Photopoint 21

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 11:27 | 44 21' 44.0" N 68 12' 30.0" W | 44,362 | -68,208 | 21 | P1000097.JPG | single | 27 | 28.75 | 25 | 27.75 | 45 | sunny, clear | IMG_0823.JPG |
| 06/17/2015 | 11:35 | 44 21' 42.0" N 68 12' 30.0" W | 44,362 | -68,208 | 21 | P1000098.JPG | single | 325 | 28.75 | 25 | 27.75 | 45 | sunny, clear | IMG_0824.JPG |

## Photopoint 22

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 11:26 | 44 21' 43.0" N 68 12' 27.0" W | 44,362 | -68,208 | 31/22 | P1000096.JPG | single | 132 | 40.25 | 37.5 | 40.125 | 30 | sunny, clear | IMG_0821.JPG |
| 06/17/2015 | 11:43 | 44 21' 44.0" N 68 12' 28.0" W | 44,362 | -68,208 | 22 | P1000099.JPG | single | 107 | 28.75 | 25 | 27.75 | 164 | sunny, clear | IMG_0825.JPG |

## Photopoint 23

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/16/2015 | 14:02 | 44 21' 47.0" N 68 12' 24.0" W | 44,363 | -68,207 | 23 | P1000048.JPG | single | 182 | 43 | N/a | N/a | 25 | light rain, medium fog | 727.JPG |
| 06/16/2015 | 14:06 | 44 21' 47.0" N 68 12' 24.0 W | 44,363 | -68,207 | 23 | P1000049.JPG | single | 130-275 | 43 | N/a | N/a | 25 | light rain, medium fog | 727.JPG |

## Photopoint 24

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/16/2015 | 14:26 | 44 21' 43.0" N 68 12' 23.0" W | 44,362 | -68,206 | 24 | P1000054.JPG | single | 197 | 43.5 | N/a | N/a | 76 | light rain, medium fog | 729.JPG |
| 06/16/2015 | 14:30 | 44 21' 44.0" N 68 12' 21.0" W | 44,362 | -68,206 | 24 | P1000055.JPG | single | 335 | 37.5 | N/a | N/a | 25 | light rain, medium fog | 730.JPG |

## Photopoint 25

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 12:06 | 44 21' 38.0" N 68 12' 18.0" W | 44,361 | -68,205 | 25 | P1000102.JPG | single | 140 | 29.375 | N/a | N/a | 25 | sunny, clear | IMG_0827.JPG |
| 06/17/2015 | 12:16 | 44 21' 38.0" N 68 12' 19.0" W | 44,361 | -68,205 | 25 | P1000105.JPG | single | 168 | 25.49 | N/a | N/a | 25 | sunny, clear | IMG_0828.JPG |

## Photopoint 26

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 14:06 | 44 21' 31.8" N 68 12' 39.5" W | 44,359 | -68,211 | 26 | P1000119.JPG | single | 246 | 43.5 | 40.75 | 42 | 65 | sunny, clear | IMG_0852.JPG |
| 06/22/2015 | 11:41 | 44 21' 14.0" N 68 12' 08.0" W | 44,354 | -68,202 | 26 | P1000199.JPG | panoramic | 242-345 | 40.75 | N/a | N/a | 25 | sunny, clear, post-rain | IMG_0920.JPG |

## Photopoint 27

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 09:34 | 44 21' 32.7" N 68 12' 21.7" W | 44,359 | -68,206 | 27 | P1000062.JPG | single | 47 | 42.25 | N/a | N/a | 25 | sunny, clear | IMG_0805.JPG |
| 06/17/2015 | 09:47 | 44 21' 30.6" N 68 12' 25.0" W | 44,359 | -68,207 | 27 | P1000069.JPG | panoramic | 227-15 | 42 | N/a | N/a | 25 | sunny, clear | IMG_0806.JPG |

## Photopoint 29

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 14:35 | 44 21' 20.5" N 68 12' 37.3" W | 44,356 | -68,21 | 29 | P1000126.JPG | single | 82 | 42 | 41 | 33.25/32.375 | 25 | sunny, clear | GOPRO PP29 6/17/15 |
| 07/07/2015 | N/a | 11:16 | N/a | N/a | 29 | 20150707_111626.JPG | single | freehand | N/a | N/a | N/a | N/a | sunny, clear | (Taken from kayak) |

## Photopoint 30

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07/07/2015 | 11:07 | N/a | N/a | N/a | 30 | 20150707_110726.JPG | single | freehand | N/a | N/a | N/a | N/a | sunny, clear | (Taken from kayak) |
| 07/07/2015 | 11:08 | N/a | N/a | N/a | 30 | 20150707_110849.JPG | single | freehand | N/a | N/a | N/a | N/a | sunny, clear | (Taken from kayak) |

## Photopoint 31

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 11:26 | 44 21' 43.0" N 68 12' 27.0" W | 44,362 | -68,208 | 31/22 | P1000096.JPG | single | 132 | 40.25 | 37.5 | 40.125 | 30 | sunny, clear | IMG_0821.JPG |

## Photopoint 32

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/29/2015 | 12:44 | 44 22' 21.8" N 68 12' 26.2" W | 44,373 | -68,207 | 32 | P1000297.JPG | single | 172 | 40.125 | N/a | N/a | 25 | sunny, clear | IMG_0977.JPG |
| 06/29/2015 | 12:48 | 44 22' 20.6" N 68 12' 26.7" W | 44,372 | -68,207 | 32 | P1000298.JPG | panoramic | 83-147 | 39.5 | N/a | N/a | 25 | sunny, clear | IMG_0978.JPG |

## Photopoint 34

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/30/2015 | 10:03 | 44 22' 45.4" N 68 12' 22.5" W | 44,379 | -68,206 | 34 | P1000311.JPG | single | 305 | 29.625 | N/a | N/a | 25 | sunny, some clouds | IMG_0983.JPG |

## Photopoint 35

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/30/2015 | 09:41 | 44 22' 47.1" N 68 12' 19.1" W | 44,38 | -68,205 | 35 | P1000301.JPG | panoramic | 278-45 | 31.125 | N/a | N/a | 25 | sunny, some clouds | IMG_0980.JPG |
| 06/30/2015 | 09:43 | 44 22' 47.1" N 68 12' 19.1" W | 44,38 | -68,205 | 35 | P1000302.JPG | single | 265 | 31.125 | N/a | N/a | 25 | sunny, some clouds | IMG_0980.JPG |

## Photopoint 36 (Near Cromwell Harbor Road)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/26/2015 | 10:38 | 44 22' 49.3" N 68 12' 18.1" W | 44,38 | -68,205 | 36 (cromwell rd) | P1000285.JPG | single | 56 | 28.625 | N/a | N/a | 25 | sunny, some clouds | IMG_0972.JPG |
| 06/26/2015 | 10:39 | 44 22' 49.3" N 68 12' 18.1" W | 44,38 | -68,205 | 36 (cromwell rd) | P1000286.JPG | single | 56 | 28.625 | N/a | N/a | 81 | sunny, some clouds | IMG_0972.JPG |

## Photopoint 36 (Near Route 3)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/26/2015 | 10:19 | 44 22' 52.9" N 68 12' 08.9" W | 44,381 | -68,202 | 36(rt.3) | P1000276.JPG | single | 100 | 29.625 | N/a | N/a | 25 | sunny, some clouds | IMG_0970.JPG |
| 06/26/2015 | 10:21 | 44 22' 52.9" N 68 12' 08.9" W | 44,381 | -68,202 | 36(rt.3) | P1000277.JPG | single | 100 | 29.625 | N/a | N/a | 112 | sunny, some clouds | IMG_0970.JPG |

## Photopoint 38

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/30/2015 | 09:22 | 44 22' 52.2" N 68 12' 08.2" W | 44,381 | -68,202 | 38 | P1000299.JPG | single | 74 | 45.375 | N/a | N/a | 25 | sunny, some clouds | IMG_0979.JPG |

## Photopoint 50 (Northern Point)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/19/2015 | 10:46 | 44 22' 00.7" N 68 12' 44.6" W | 44,367 | -68,212 | 50 | P1000161.JPG | panoramic | 194-260 | 41.5 | N/a | N/a | 25 | medium overcast | IMG_0883.JPG |
| 06/19/2015 | 11:01 | 44 22' 00.4" N 68 12' 46.0" W | 44,367 | -68,213 | 50 | P1000172.JPG | single | 99 | 42 | N/a | N/a | 25 | medium overcast | IMG_0896.JPG |

## Photopoint 50 (Southern Point)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/25/2015 | 12:18 | 44 21' 55.8" N 68 12' 42.3" W | 44,366 | -68,212 | 50 | P1000263.JPG | single | 152 | 42.375 | N/a | N/a | 25 | sunny, clear | IMG_0962.JPG |
| 06/25/2015 | 12:24 | 44 21' 55.8" N 68 12' 42.3" W | 44,366 | -68,212 | 50 | P1000265.JPG | panoramic | 344-124 | 42.375 | N/a | N/a | 25 | sunny, clear | IMG_0962.JPG |

## Photopoint 54

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/19/2015 | 09:47 | 44 21' 46.4" N 68 12' 28.1" W | 44,363 | -68,208 | 54 | P1000145.JPG | single | 352 | 43.25 | N/a | N/a | 25 | medium overcast | IMG_0875.JPG |
| 06/19/2015 | 10:15 | 44 21' 42.3" N 68 12' 27.7" W | 44,362 | -68,208 | 54 | P1000158.JPG | panoramic | 120-190 | 42.75 | N/a | N/a | 25 | medium overcast | IMG_0880.JPG |

## Photopoint 55 (Near The Tarn)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 09:58 | 46 21' 30.7" N 68 12' 25.0" W | 46,359 | -68,207 | 55 | P1000074.JPG | single | 19 | 38.25 | N/a | N/a | 25 | sunny, clear | GOPR2538.JPG |
| 06/17/2015 | 09:54 | 45 21' 30.6" N 68 12' 25.0" W | 45,359 | -68,207 | 55 | P1000071.JPG | panoramic | 320-106 | 41.25 | N/a | N/a | 25 | sunny, clear | IMG_0808.JPG |

## Photopoint 55 (On Jesup Path)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 10:12 | 44 21' 33.1" N 68 12' 26.7" W | 44,359 | -68,207 | 55 | P1000081.JPG | single | 16 | 39.5 | N/a | N/a | 25 | sunny, clear | IMG_0809.JPG |
| 06/17/2015 | 10:24 | 44 21' 35.4" N 68 12' 26.3" W | 44,36 | -68,207 | 55 | P1000083.JPG | panoramic | 153-271 | 28.49 | N/a | N/a | 25 | sunny, clear | IMG_0810.JPG |

## Photopoint 57 (North)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/19/2015 | 11:54 | 44 22' 05.0" N 68 12' 40.9" W | 44,368 | -68,211 | 57 | P1000190.JPG | single | 39 | 42.25 | N/a | N/a | 25 | medium overcast | IMG_0912.JPG |
| 06/22/2015 | 13:46 | 44 22' 13.7" N 68 12' 35.9" W | 44,37 | -68,21 | 57 | P1000209.JPG | single | 40 | 43 | N/a | N/a | 25 | sunny, clear, post-rain | IMG_0931.JPG |

## Photopoint 57 (South)

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 10:43 | 44 21' 35.3" N 68 12' 26.6" W | 44,36 | -68,207 | 57 | P1000084.JPG | single | 34 | 42 | N/a | N/a | 25 | sunny, clear | IMG_0812.JPG |
| 06/17/2015 | 11:14 | 44 21' 38.0" N 68 12' 26.9" W | 44,361 | -68,207 | 57 | P1000094.JPG | single | 14 | 43 | N/a | N/a | 25 | sunny, clear | IMG_0819.JPG |

## Beech Bark Disease

| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 06/17/2015 | 11:10 | 44 21' 36.6" N 68 12' 26.6" W | 44,36 | -68,207 | Beech Bark Disease | P1000092.JPG | single | 125 | 41.5 | N/a | N/a | 104 | sunny, clear | IMG_0818.JPG |
| 06/17/2015 | 11:11 | 44 21' 36.6" N 68 12' 26.6" W | 44,361 | -68,207 | Beech Bark Disease | P1000093.JPG | single | 125 | 41.5 | N/a | N/a | 196 | sunny, clear | IMG_0818.JPG |

## Old River Intersection

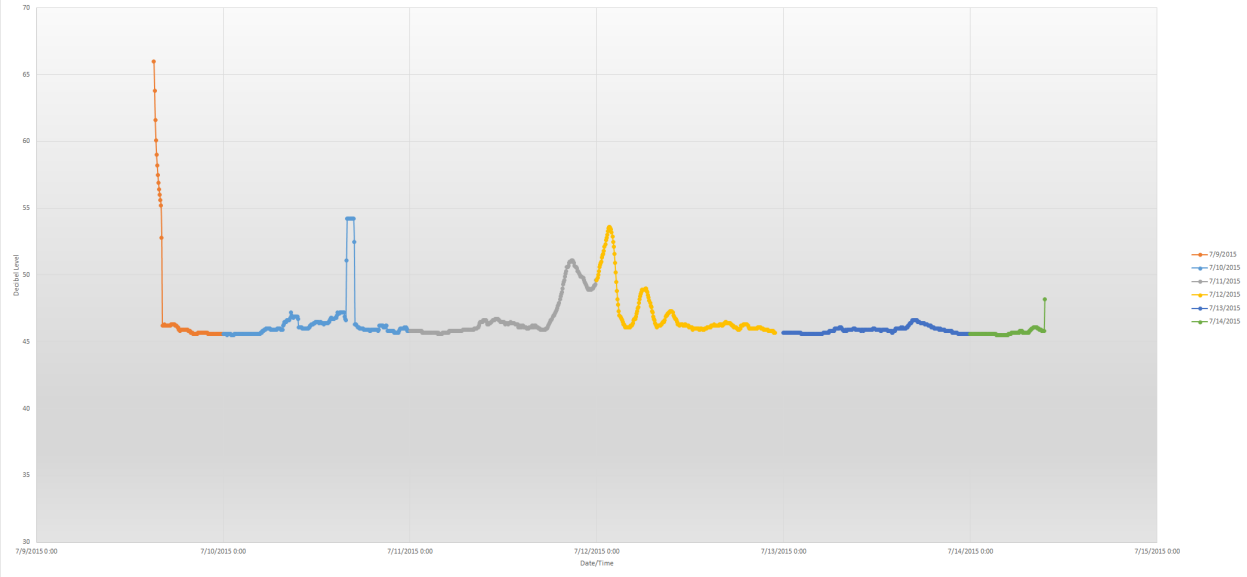
| Date | Time | GPS | Latitude | Longitude | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) | lead leg (in) | back legs (in) | Zoom (mm) | Weather | Associated Site Photo File Name |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 07/02/2015 | 10:27 | 44 22' 31.7" N 68 12' 26.6" W | 44,375 | -68,207 | Old River Int. | P1000328.JPG | single | 177 | 40.75 | N/a | N/a | 25 | sunny, clear | IMG_0994.JPG |
| 07/02/2015 | 10:40 | 44 22' 32.5" N 68 12' 26.3" W | 44,376 | -68,207 | Old River Int. | P1000333.JPG | single | 184 | 32.5 | N/a | N/a | 25 | sunny, clear | IMG_0998.JPG |

## Section 4.2 Noise Level Documentation

Two locations were visited to record noise levels with the NTI XL2. Several others were attempted, but due to hardware failure, did not produce useable data. Graphs of both the average decibel levels and frequency measurements will be presented for each five day period. The Huguenot location has only decibel level data available due to a miscalibration of the NTI settings.

### Section 4.2.1 Huguenot Head Site

| Name | Date | GPS | Bad Time(s) |
|---|---|---|---|
| Huguenot | 7/9/2015-7/14/2015 | 44 21' 29.3" N 68 12' 09.5" W | 3:15-4:00 PM (7/10/2015) |

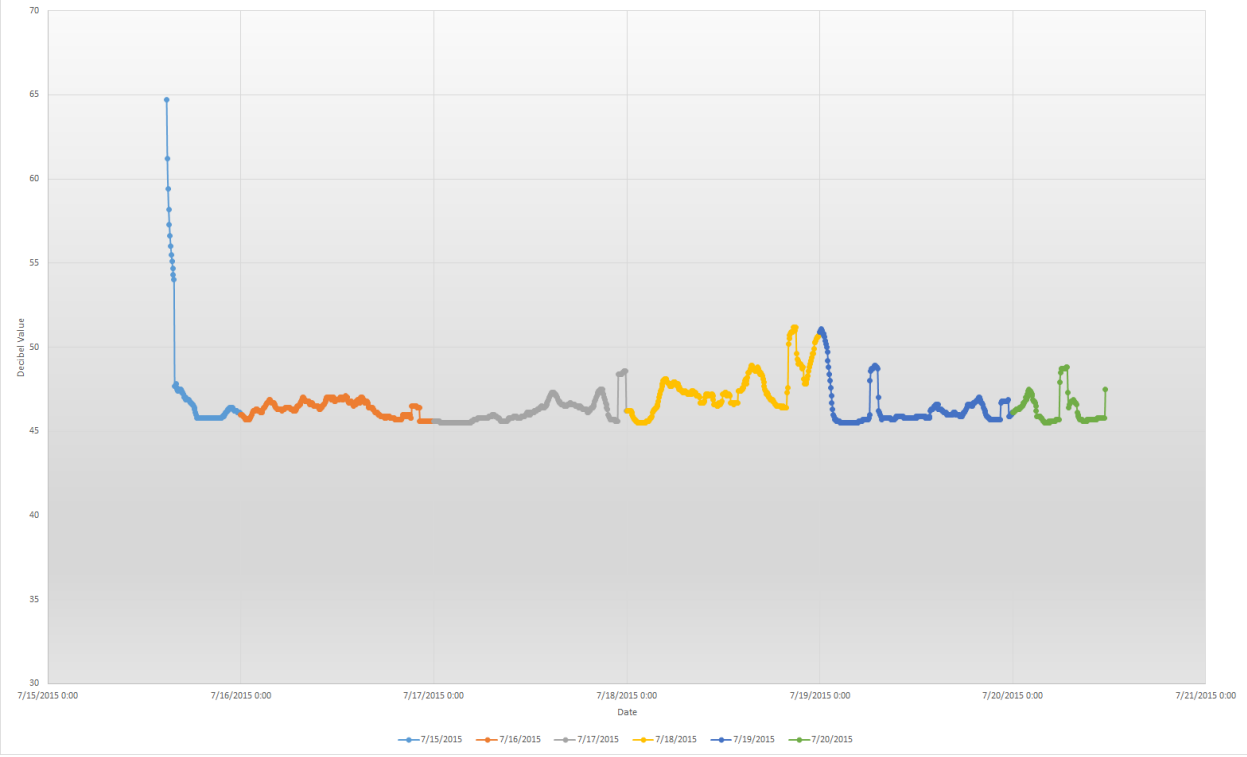



Graph of Decibel Levels on Huguenot Head from 7/9/2015-7/15/2015

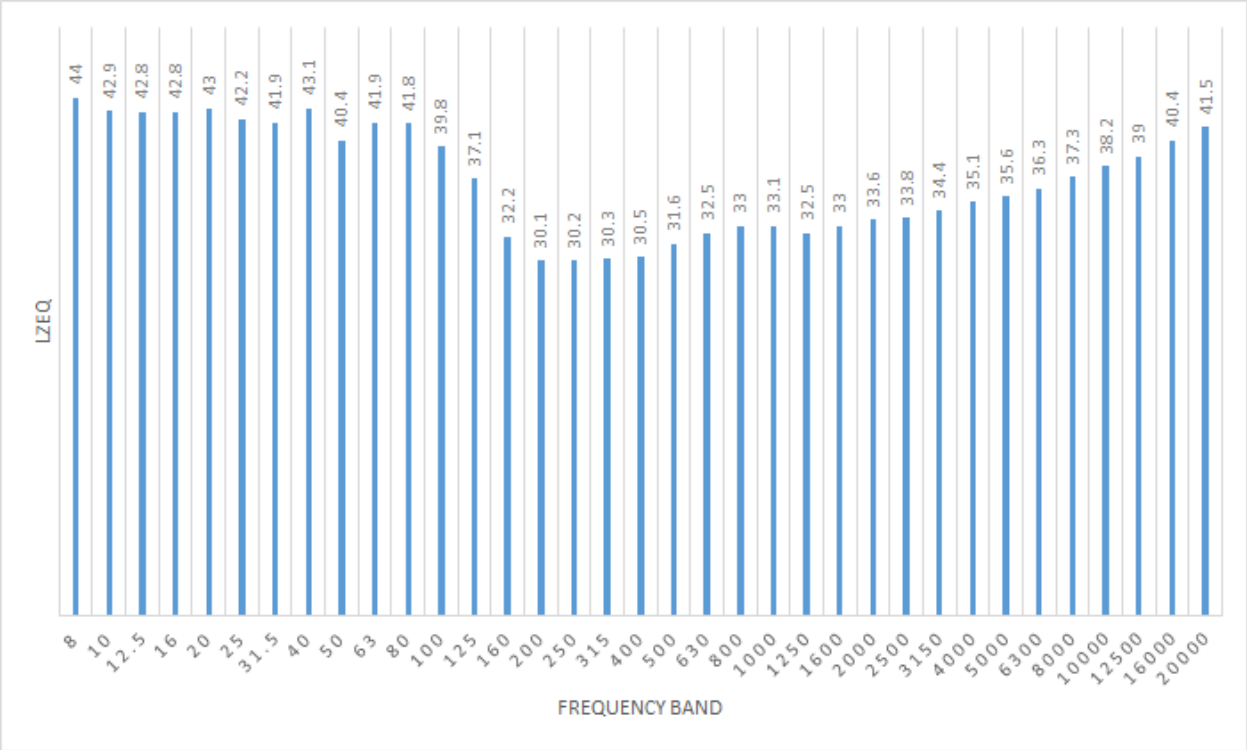
Setup on Huguenot Head from 7/9/2015-7/15/2015

## Section 4.2.2 Great Meadow Site

| Name | Date | GPS | Bad Time(s) |
|---|---|---|---|
| Great Meadow | 7/15/2015-7/20/2015 | 44 21' 54" N 68 12' 35" W | None |




Graph of Decibel Levels in the Great Meadow from 7/15/2015-7/20/2015




Graph of Frequency Measurements in the Great Meadow from 7/15/2015-7/20/2015

Setup for the Great Meadow from 7/15/2015-7/20/2015

## Section 4.3 Conclusions

Over the course of the project, a database of photographs as well as a few noise level recordings was created. These elements of documentation capture the state of the Cromwell Brook Watershed at present, laying the groundwork for repeat photography. The majority of the

documented locations did in fact have problems that corresponded to the provided map. Additionally, issues outside those provided were documented, capturing more completely the state of the watershed. This work will be a valuable asset for Acadia National Park going forward as a baseline of the area and a model for future documentation of this nature.

Additionally, photographs of the Tarn, an area of the watershed, taken from 1918-1923, were acquired through Acadia National Park's archives. These photographs were reproduced as a proof-of-concept for the future of this project's database.

The Tarn in 1918 and in 2015, respectively

The Tarn in 1923 and in 2015, respectively

## Section 4.4 Recommendations

Although a great amount of photographic and audio data was gathered, more can be done to improve this work. Iterating on the results and procedures presented so that additional information can be gathered will benefit both Acadia National Park and WPI.

Issues with the batteries used for the NTI XL2 derailed the audio portion of the project. The NTI's default battery pack prevents the external batteries from functioning properly. This caused the unit to last only 4-5 hours, compared to the typical 120 hours on the same recording settings. This ruined the first attempted recording in the Great Meadow, wasting a week. *(See Section 6.4 for more on battery life)* Removing the default battery pack before recording will solve this issue, allowing more of the area to be covered, and for longer periods of time.

Lastly, the work presented here is applicable to other areas of Acadia National Park. Expanding to cover different watersheds, or assigning additional teams to work on multiple watersheds simultaneously would greatly assist the documentation effort.

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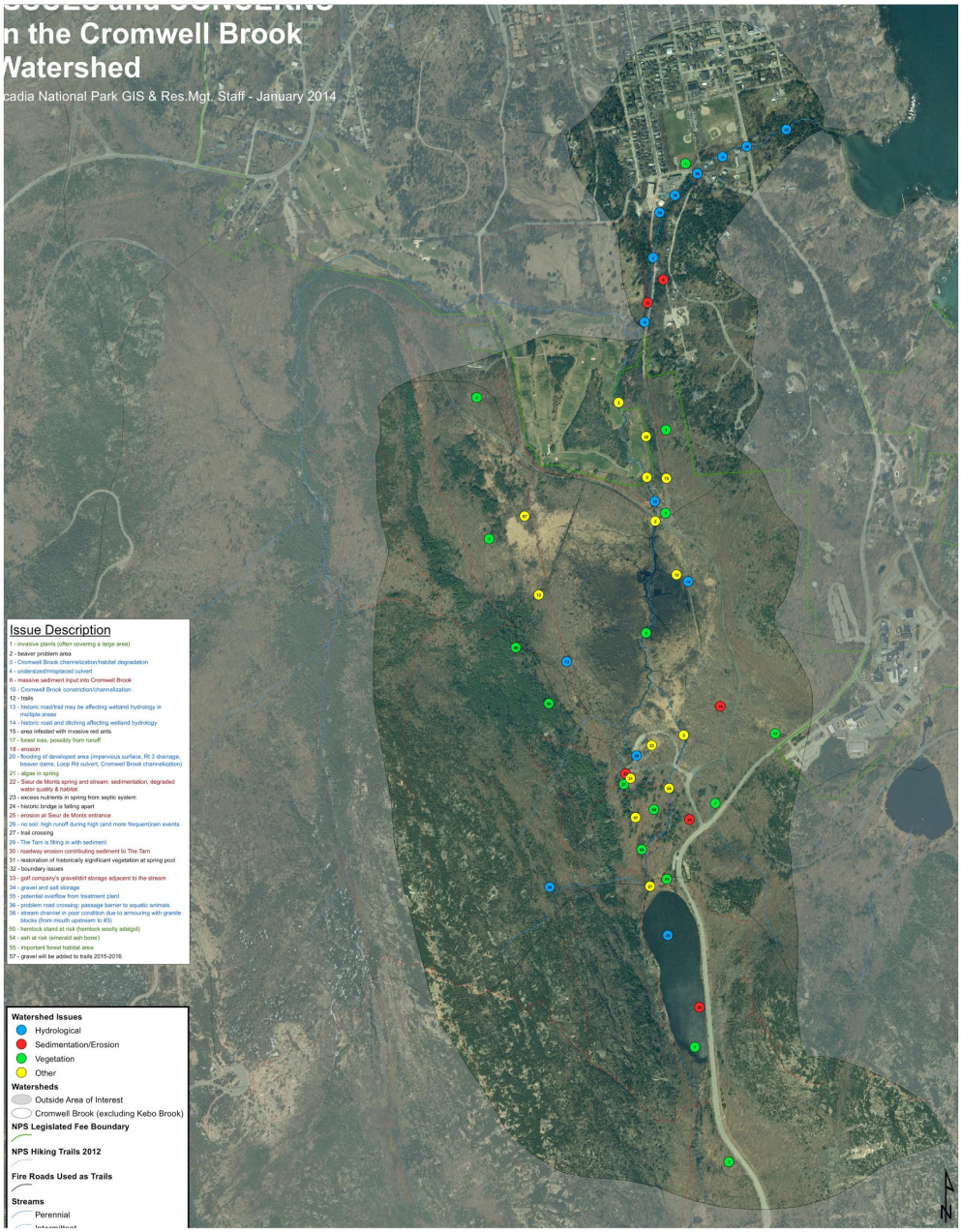
# Chapter 6: Appendix

## Section 6.1: Figures and Tables

### Figure 1: Map of the Cromwell Brook Watershed with points of ecological concern



## Figure 2: Photopoint Documentation Table (Examples provided)

| Date | Time | GPS | Photo Location | Photo Filename | Type | Compass Azimuth | Tripod Height (in) |
|---|---|---|---|---|---|---|---|
| 6/16/15 | 1:45 | 44 21' 46.0" N<br>68 12' 21.0" W | 2 | P1000044.JPG | Single | 110 | 41.9 |
| 6/16/15 | 1:52 | 44 21' 46.0" N<br>68 12' 21.0" W | 2 | P1000045.JPG | Panoramic | 55-200 | 41.9 |

| Lead Leg (in) | Back Legs (in) | Zoom (mm) | Weather | Description |
|---|---|---|---|---|
| N/A | N/A | 25 | Light rain, medium fog | between service road and cromwell brook, near beaver lodge |
| N/A | N/A | 25 | Light rain, medium fog | between service road and cromwell brook, near beaver lodge |

## Figure 3: Photopoint Site Index (Examples Provided)

| Date | Time | GPS | Photo Location | Site Photo Filename | Associated Photo Filenames |
|---|---|---|---|---|---|
| 6/16/15 | 1:45-1:52 | 42 21' 46" N<br>68 12' 21" W | 2 | 726.JPG | P1000044.JPG |
| | | | | 726.JPG | P1000045.JPG |

## Figure 4: Lumix DMC-FZ1000 Camera

**Figure 5: Velbon Ex 330 Tripod**

**Figure 6: NTI XL2 recorder with M2230 microphone**

**Figure 7: 12 volt car battery**

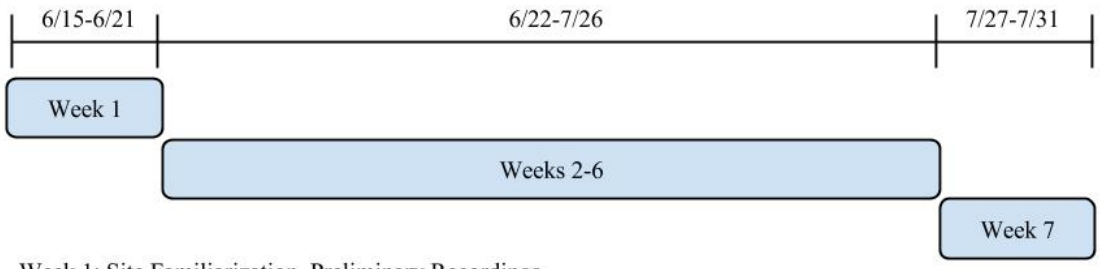
**Figure 8: Garmin eTrex H GPS unit**

**Figure 9: Pelican Waterproof Case and Auray Windscreen**

**Figure 10: Vortex Media Storm Jacket**

**Figure 11: Military Compass and Tape Measure**

**Figure 12: Project Timeline**




Week 1: Site Familiarization, Preliminary Recordings

Weeks 2-6: On-site Noise Level and Photography Documentation

Week 7: Project Finalization

**Figure 13: Photopoint Master List (Examples provided)**

| Photopoint | Status | Notes | Complete | Uncertain |
|---|---|---|---|---|
| 1 (In The Tarn) | Complete | | 38 | 2 |
| 1 (Near Route 3) | Don't worry | Invasive species team took care of this | | |
| 1 (Near Town Tennis Courts) | Complete | | **Not Done** | **Don't Worry** |
| 1 (Near Jesup Path) | Don't worry | Invasive species team took care of this | 2 | 8 |
| 1 (Immediately South of The Tarn) | Don't worry | Invasive species team took care of this | | |
| 1 (Wicked South of The Tarn) | Don't worry | Invasive species team took care of this | Updated for 7/6 | |
| 1 (Middle of the Great Meadow) | Don't worry | Invasive species team took care of this | | |
| 1 (Near Point 2 in Great Meadow, 10) | Don't worry | Invasive species team took care of this | | |
| 1 (Near 15 in Great Meadow Loop Trail) | Don't worry | Invasive species team took care of this | | |
| 2 (In Great Meadow, Near Park Loop Road) | Complete | | | |
| 2 (Near Sieur De Monts) | Complete | | | |
| 2 (North of Point 32) | Complete | | | |
| 2 (South of Point 32) | Complete | | | |
| 3 | Complete | | | |
| 4 (Near Golf Course Gravel Storage) | Complete | | | |
| 4 (North of Point 6) | Complete | | | |
| 6 | Complete | | | |
| 10 | Complete | | | |
| 12 | Complete | | | |
| 13 | Uncertain | Hydrology, needs clarification | | |
| 14 | Complete | | | |
| 15 (Near Point 14) | Complete | | | |
| 15 (Great Meadow Loop Trail) | Complete | | | |
| 17 | Complete | | | |
| 18 | Complete | | | |

**Figure 14: Lumix DMC-FZ1000 Camera Specifications**

| | |
|---|---|
| **Pixels** | |
| **Camera Effective Pixels** | 20.1 Megapixels |
| **Sensor** | |
| **Sensor Size / Total Pixels / Filter** | 1-inch High Sensitivity MOS Sensor / Total Pixel Number 20.9 Megapixels / Primary Color Filter |
| **Lens** | |
| **Aperture** | F2.8 - 4.0 / Multistage Iris Diaphragm (Still Image: F2.8 - 8.0 (W), F4.0 - 8.0 (T), Motion Picture: F2.8 - 11.0 (W), F4.0 - 11.0 (T)) |
| **Optical Zoom** | 16x |
| **Focal Length** | f = 9.1 - 146mm |
| **Focal Length** | (27 - 432mm in 35mm equiv. in 4:3) |
| **Focal Length** | (25 - 400mm in 35mm equiv. in 3:2) |
| **Focal Length** | (26 - 416mm in 35mm equiv. in 16:9) |
| **Focal Length** | (32 - 512mm in 35mm equiv. in 1:1) |
| **Focal Length** | (26 - 416mm in 35mm equiv. in 16:9 video recording / O.I.S. Off / Level Shot function Off) |
| **Focal Length** | (28 - 448mm in 35mm equiv. in 16:9 video recording / O.I.S. On / Level Shot function Off) |
| **Focal Length** | (31 - 496mm in 35mm equiv. in 16:9 video recording / O.I.S. On / Level Shot function On) |
| **Focal Length** | (37 - 592mm in 35mm equiv. in 4K video recording) |
| **Extra Optical Zoom (EZ)** | 22.4x (3:2 / 10M (M)), 32x (3:2 / 5M (S)) |
| **Intelligent Zoom** | 32x |
| **Lens** | LEICA DC VARIO-ELMARIT |
| **Lens** | 15 elements in 11 groups |
| **Lens** | (5 Aspherical Lenses / 8 Aspherical Surfaces / 4 ED Lenses) |
| **2- Speed Zoom** | N/A |
| **Changing of Zoom Speed** | 5-Speed Zoom |
| **Optical Image Stabilizer** | N/A |
| **Optical Image Stabilizer/Five Axis Correction** | HYBRID O.I.S. +* / Yes* * Except for the 4K video recording and high-speed video recording. |
| **Digital Zoom** | Max. 4x |
| **Conversion Lens Compatibility** | - |
| **Focus** | |
| **Focusing Area** | Normal: Wide 30 cm - infinity / Tele 100 cm - infinity |
| **Focusing Area** | AF Macro / MF / Intelligent Auto / Motion Picture: Wide 3 cm - infinity / Tele 100 cm - infinity |
| **AF Assist Lamp** | Yes (On / Off) |
| **Focus** | AFS (Single) / AFF (Flexible) / AFC (Continuous) / MF |
| **Focus** | Normal / AF Macro / Macro Zoom, Quick AF On / Off (on in Intelligent Auto), Low Light AF, AF/AE Lock Button, AF Area Select, AF Tracking, Eye Sensor AF, Focus Peaking, One Shot AF (Set the Fn button in custom menu to AF-ON) |
| **AF Metering** | Face/Eye Detection / Tracking / 49-area / Custom Multi / 1-area (flexible / scalable) / Pinpoint |
| **Shutter** | |
| **Shutter Speed** | Still Image: |
| **Shutter Speed** | Approx. 60 - 1/4,000 sec (Mechanical Shutter) |
| **Shutter Speed** | Approx. 1 - 1/16,000 sec (Electronic Shutter) |
| **Shutter Speed** | Bulb (Approx. 120 sec) |
| **Shutter Speed** | Motion Picture: |
| **Shutter Speed** | Approx. 1/30 - 1/16,000 sec |
| **Shutter Speed** | Approx. 1/25 - 1/16,000 sec (AVCHD in FHD 24p) |
| **Shutter Speed** | Approx. 1/2 - 1/16,000 sec (Creative Video M Mode / MF Mode) |
| **Finder** | |
| **Viewfinder** | 0.39" OLED LVF (Live View Finder) (2359K dots), Field of View: Approx. 100%, |
| **Viewfinder** | Magnification: Approx. 1.88x / 0.7x (35mm equiv.), Eye Sensor |

## Section 6.2 Converting GPS Coordinates

GPS coordinates were initially recorded in the degrees-minutes-seconds (DMS) format. A script was written to automatically convert all of these to latitude and longitude, or decimal, format. This was written to work with Google Script, as Google Sheets was used to create the photo index. Microsoft Excel runs scripts through Visual Basic, so this will not work through a

simple copy-paste method. It is also important to format coordinates properly so the script can function.

```
/*
Functions for converting DMS (Decimal Minutes Seconds) notation
to decimal (latitude longitude) notation

example of input
42 21' 46" N 68 12' 21'' W

example of noSpaces array:
{42, 21, 46, N, 68, 12, 21, W}

*/
function getLat(DMSString) {
  //Isolate the measurements and assign them to variables
  var output = 0;
  var noSpaces = DMSString.split(" ");
  var Deg = noSpaces[0].substring(0, 2);
  var Min = noSpaces[1].substring(0, 2);
  var Sec = noSpaces[2].substring(0, 4); //Requires that all seconds be entered with 4
characters, but increases accuracy

  //Convert DMS to decimal and round to 3 decimal places
  output = parseFloat(Deg)+parseFloat((Min/60))+parseFloat((Sec/3600));
  output = Math.round(output * 1000)/1000;

  //Account for negative Latitude
  if (noSpaces[3] == "S")
  {
    output = output*-1;
  }

  return output;
}

function getLong(DMSString)
{
  //Isolate the measurements and assign them to variables
  var output = 0;
  var noSpaces = DMSString.split(" ");
  var Deg = noSpaces[4].substring(0, 2);
  var Min = noSpaces[5].substring(0, 2);
  var Sec = noSpaces[6].substring(0, 4); //Requires that all seconds be entered with 4
characters, but increases accuracy

  //Convert DMS to decimal and round to 3 decimal places
  output = parseFloat(Deg)+parseFloat((Min/60))+parseFloat((Sec/3600));
  output = Math.round(output * 1000)/1000;

  //Account for negative Longitude
  if (noSpaces[7] == "W")
  {
    output = output*-1;
  }

  return parseFloat(output);
```

}

## Section 6.3 NTI XL2 Data Extraction

The NTI, if run with the proper settings, should produce two files. The first follows the naming format of "Date_SLM_00X_123_Log.txt", the second follows the format of "Date_SLM_00X_RTA_3rd_Report.txt". Two examples would be (2015-04-28_SLM_000_123_Log.txt) and (2015-04-28_SLM_002_RTA_3rd_Report.txt). The file with the "123" in it's name contains decibel level readings. The file with "RTA" in it's name contains frequency data. It is possible to use the RTA log instead of the report. This would allow for the possibility of cutting out bad data, thus increasing accuracy. This would, however, require code modification. As the current scripts are setup, data trimming is not possible. For scripts that allow data trimming, please see the report by the 2013 Bar Harbor Soundscape Analysis IQP.

In order to produce excel files from the NTI output, the two files need to be placed in a folder named "raw_audio", located within a folder containing the necessary python scripts. The file "AutomatedGenerateAll.py" then needs to be run from a numpy (a python-module that adds mathematical capabilities) capable python prompt. Anaconda command prompt worked admirably in this regard. Take note that before running the scripts, the values for "raw" and "site" must be changed in the file AutomatedGenerateAll.py.

Running the scripts will produce a number of files in the same folder as the scripts are located. The files with "All" in their name would be used if retrieving data every day. In that case they would be filled using the stitching script. In the code included, calls to the stitching script have been commented out, as for this project data was only retrieved at the end of the five-day periods. The files of most use are the ones ending in "DB_day1.csv" and "3rd_day1.csv". The former contains decibel level averages, the latter contains frequency data.

The scripts used for this project, modified from ones provided by the 2013 soundscape

analysis team, are included below.

AutomatedGenerateAll.py

```
'''

import os
import csv
import CreateCSV as create
import StitchingData as stitch
import Calc_Statistics as calc

#Variables that the user must specify.
#raw: The complete path where all of the raw db and raw 3rd data files from the XL2 are
located.
#site: The complete site name (safest without spaces) that all generated files will use in
their
# file names.
#update: update should be marked as 'True' if the user wants to check to regenerate stitched
files
# with newer data files or days. The user should mark 'False' if they do not want to run the
# stitching programs at this time
#cut: cut should be true if the user wants to run the cutting program that cuts out the bad
times
# in their data

raw = "C:\Users\Alexi\Documents\AA-School\IQP\Python_Mod_Log_Report\\raw_audio"
site = "TestSite"
update = True
cut = False

#Interference and maintentance times specified in this cutTimes list in the format
# [[[date],[startTimeCut],[endTimeCut]],[...],[...]]
# [[YYYY,DD,MM],[hh,mm,ss],[hh,mm,ss]]
#
# List all times to be cut
#
# NOTE: Cut times are only applied to 'All' files that would be used for computing
# averages on the basis that maintenence interference would not greatly impact
# the sampled graphs for viewing purposes.

cutTimes = [[[2013,6,28],[10,00,00],[17,05,00]],
                      [[2013,6,29],[17,00,00],[17,20,00]],
                      [[2013,6,30],[16,51,00],[17,8,00]],
                      [[2013,7,1],[16,52,00],[17,9,00]],
                      [[2013,7,2],[16,17,00],[16,30,00]],
                      [[2013,7,3],[17,01,00],[17,22,00]],
                      [[2013,7,4],[17,50,00],[18,06,00]],
                      [[2013,7,5],[15,40,00],[17,20,00]]]
#create the raw dir if the one given doesn't exist
if not os.path.exists(raw):
       os.makedirs(raw)

#change directories to given path with raw data and get parent
os.chdir(raw)
```

```
parent = os.path.split(raw)[0]
print parent
dbDay = os.path.join(parent,'dbDaily')
print dbDay
freqDay = os.path.join(parent,'3rdDaily')
print freqDay
dbAll = os.path.join(parent,'AllDB')
print dbAll
freqAll = os.path.join(parent,'All3rd')
print freqAll

#A list of all the raw data files
list = os.listdir(raw)
print list
#A list of all the generated files inside of the main site location folder
parentList = [x.split('.')[0] for x in os.listdir(parent)]

#Loops through the raw data files in the directory given,
#creating the daily decibel csv files for graphing (5 minute sample)
#along with the spectrogram data. Both types of files are created
#in the parent directory of the raw files folder
dayCnt = 0
print 'begin'
for count,file in enumerate(sorted(list)):
 if count %2 == 0: #increments the day counter every other file
       dayCnt += 1
 dbFileName = site+'_DB_day'+str(dayCnt)#Create the new decibel file name
 specFileName = site+'_3rd_day'+str(dayCnt)#Create the new spec file name

 print file
 #If the current file is a DB file
 if file.split('_')[3] == '123':

        if dbFileName not in parentList: #If the dbFile is not already generated
               dbData = create.CSVcreate(db_file=file)
               dbData.db_CSV(os.path.join(parent,dbFileName+'.csv'), True)#Create the
sampled dB CSV file

        if 'All_'+dbFileName not in parentList: #if the All_dbFile is not already generated
               dbData = create.CSVcreate(db_file=file)
               unsampledFileName = 'All_' + dbFileName
               dbData.db_CSV(os.path.join(parent,unsampledFileName+'.csv'),False)#Create the
All_dB unsampled CSV file

 #If the current file is a Frequency file
 elif file.split('_')[3] == 'RTA':

        #print "Working on "+file;

        if specFileName not in parentList: #If the specFile is not already generated
               specData = create.CSVcreate(spec_file=file)
               specData.spec_CSV(os.path.join(parent,specFileName+'.csv')) #Create the freq
CSV file

        if 'All_'+specFileName not in parentList: #If the All_specFile is not already
generated
               specData = create.CSVcreate(spec_file=file)
               specData.write_All_Spec(os.path.join(parent,'All_'+specFileName+'.csv'))
```

```
#Create the All_specFile CSV file

print "Finished making averages"

#make to change directory to the parent, main site folder
os.chdir(parent)

#if the db Stitch file is not already generated, or it is desired to update the file,
#then create or update the stitch file with all available day files
# if site+'_Stitch' not in parentList or update:
       # stitch.stitch(site+'_Stitch.csv', True,
                               # site+'_DB_day1.csv',
                               # site+'_DB_day2.csv',
                               # site+'_DB_day3.csv',
                               # site+'_DB_day4.csv',
                               # site+'_DB_day5.csv',
                               # site+'_DB_day6.csv',
                               # site+'_DB_day7.csv')

       # #calculate the rolling average for the stitched dB file for graphing purposes and
put
       # #it in a separate file
       # stitch.appendAverages(site+'_Stitch.csv', 7)
#if the All_db Stitch file is not already generated, or it is desired to update the file,
#then create or update the stitch file with all available day files
# if 'All_'+site+'_Stitch' not in parentList or update:
        # stitch.stitch('All_'+site+'_Stitch.csv', False,
                                # 'All_'+site+'_DB_day1.csv',
                                # 'All_'+site+'_DB_day2.csv',
                                # 'All_'+site+'_DB_day3.csv',
                                # 'All_'+site+'_DB_day4.csv',
                                # 'All_'+site+'_DB_day5.csv',
                                # 'All_'+site+'_DB_day6.csv',
                                # 'All_'+site+'_DB_day7.csv')
#if the All_3rd freq Stitch file is not already generated, or it is desired to update the
file,
#then create or update the stitch file with all available day files
# if 'All_'+site+'_3rd_Stitch' not in parentList or update:
       # stitch.stitch('All_'+site+'_3rd_Stitch.csv', False,
                               # 'All_'+site+'_3rd_day1.csv',
                               # 'All_'+site+'_3rd_day2.csv',
                               # 'All_'+site+'_3rd_day3.csv',
                               # 'All_'+site+'_3rd_day4.csv',
                               # 'All_'+site+'_3rd_day5.csv',
                               # 'All_'+site+'_3rd_day6.csv',
                               # 'All_'+site+'_3rd_day7.csv')
# if cut:
       # for timeStamp in cutTimes:
              #
calc.cutTime('All_'+site+'_Stitch.csv',timeStamp[0],timeStamp[1],timeStamp[2])
              #
calc.cutTime('All_'+site+'_3rd_Stitch.csv',timeStamp[0],timeStamp[1],timeStamp[2])
#For right now, you can only run one statistics function at a time. Uncomment the one you
need, and run
#hourlyLeq,hourlyL50,hourlyL90 = calc.averageHourly('All_'+site+'_Stitch.csv')
#ovrLeq,overL50,overL90 = calc.overallAverages('All_'+site+'_Stitch.csv')
#dayAvg,nightAvg = calc.dayNightAverages('All_'+site+'_Stitch.csv')
```

Calc_Statistics.py

```
'''
Created on May 18, 2013
Calc_Statistics is used for all the different type of calculations that can be done
on the data already contained in CSV files
@author: Matt Costi
'''
import csv
import operator
import datetime

#Calculates both the L50 and L90 percents for a given file
def nthPercent(dbFile):
        csv_reader = csv.reader(open(dbFile,'r'))
        sortedList = sorted(csv_reader, key=operator.itemgetter(1), reverse=False)
        l = len(sortedList)
        print sortedList[:20]
        l50 = sortedList[l/2]
        l90 = sortedList[l-int(l * .9)]
        return l50[1],l90[1]
#Cuts data at specific timestamps from the given file, usually because of
#maintenance and interference
#
#input date format: [year,month,day]
#input time format: [hour,mins,sec]
def cutTime(dbFile,date,sTime,eTime):
        #prepare the CSV Reader, opening the specified file
        reader = csv.reader(open(dbFile, 'r'))

        #convert the entered timestamps into start and end datetime objects
        start = datetime.datetime(date[0],date[1],date[2],sTime[0],sTime[1],sTime[2])
        end = datetime.datetime(date[0],date[1],date[2],eTime[0],eTime[1],eTime[2])

        #list that contains all of the data that is not cut
        correctedData = []
        for row in reader:
                if row:
                        #parses the neccessary time info from the row
                        year,month,day = row[0].split(' ')[0].split('-')
                        hours,mins,secs = row[0].split(' ')[1].split(':')

                        #Convert all date data into ints
                        year = int(year)
                        month = int(month)
                        day = int(day)
                        hours = int(hours)
                        mins = int(mins)
                        secs = int(secs)

                        #the current timestamp object in the row
                        timeStamp = datetime.datetime(year,month,day,hours,mins,secs)

                        #if the timestamp lies between the start and end times, do nothing
                        if start <= timeStamp and timeStamp <= end:
                                None
                        elif row:
                                correctedData.append(row)
```

```
        #prepare the CSV Writer and overwrite everything in the given file with
        #the corrected data points
        writer = csv.writer(open(dbFile,'wb'),dialect='excel')
        for row in correctedData:
              writer.writerow(row)
#takes a stitch of site's complete,un-sampled,
#week of data and averages each hour
def averageHourly(siteFile):
        hours = {}
        averages = {}
        l50 = {}
        l90 = {}

        #prepare the CSV Reader
        reader = csv.reader(open(siteFile, 'r'))
        for row in reader:
              hour = row[0].split(' ')[1].split(':')[0] #get the hour from the row

               #Add the data point for that hour to the dictionary
              if hour not in hours:
                     list = [float(row[1])]
                     hours[hour] = (1,float(row[1]),list)
              else:
                     count,sums,hourList = hours[hour]
                     hourList.append(float(row[1]))
                     hours[hour] = (count+1,sums+float(row[1]),hourList)

        #Loop through each hour in the dictionary and calculate the average for the hour
        for hour in hours.keys():
               if hour not in averages:
                      count,sums,hourList = hours[hour]
                      hourList = sorted(hourList)
                      length = len(hourList)
                      l50[hour] = hourList[length/2]
                      l90[hour] = hourList[length-int(length * .9)]
                      averages[hour] = sums/count
        count = 0
        for key in sorted(averages.iterkeys()):
               print "%s: Leq: %s, L50: %s, L90: %s" %
(count,averages[key],l50[key],l90[key])
               count +=1
        return averages,l50,l90
#calculate the overall averages of Leq, L50, and L90
def overallAverages(siteFile):
        hourlyAvgs,l50,l90 = averageHourly(siteFile)
        Leq = sum(hourlyAvgs.values())/24
        L50,L90 = nthPercent(siteFile)
        print "Leq: %s, L50: %s, L90: %s" % (Leq,L50,L90)
        return Leq,L50,L90

#calculate the averages, splitting the data into day and night
def dayNightAverages(siteFile):
        reader = csv.reader(open(siteFile,'r'))
        dayData = []
        nightData = []
        for row in reader:
               hour = row[0].split(' ')[1].split(':')[0]
               print hour
```

```
                if (7 <= int(hour)) and (int(hour) < 19):
                        dayData.append(float(row[1]))
                else:
                        nightData.append(float(row[1]))

        dayLen = len(dayData)
        nightLen = len(nightData)

        print dayLen, nightLen

        orderedDay = sorted(dayData)
        orderedNight = sorted(nightData)

        dLeq = sum(dayData)/len(dayData)
        nLeq = sum(nightData)/len(nightData)
        dL50 = orderedDay[dayLen/2]
        nL50 = orderedNight[nightLen/2]

        dL90 = orderedDay[dayLen-int(dayLen * .9)]
        nL90 = orderedNight[nightLen-int(nightLen * .9)]

        print 'Daytime: Leq= %s, L50=%s, L90=%s' % (dLeq,dL50,dL90)
        print 'NightTime: Leq= %s, L50=%s, L90=%s' % (nLeq,nL50,nL90)
        return (dLeq,dL50,dL90),(nLeq,nL50,nL90)
#Averages all of the frequency columns from an 'All_3rd' file.
#
#WARNING: THIS IS AN INCREDIBLY SLOW AND COSTLY PROCCESS AND HAS NOT BEEN FULLY TESTED.
# SPREADSHEET PROGRAMS LIKE EXCEL ARE RECOMMENDED TO AVERAGE THE FREQUENCY COLUMNS
# MUCH FASTER
def averageFrequencies(siteFile):
        frequencies =
[12.5,16.0,20.0,25.0,31.5,40.0,50.0,63.0,80.0,100.0,125.0,160.0,200.0,250.0,315.0,400.0,500.
0,630.0,800.0,

1000.0,1250.0,1600.0,2000.0,2500.0,3150.0,4000.0,5000.0,6300.0,8000.0,10000.0,12500.0,16000.
0,20000.0]
        decibels = []
        reader = csv.reader(open(siteFile,'r'))

        count = 0
        print 'done'
        for row in reader:
              # print row
               for i in range(len(frequencies)):
                       if len(decibels) > i:
                              decibels[i] += row[i+1]
                       else:
                              decibels.append(row[i+1])
               count +=1

        for i in range(len(decibels)):
              print '%s: %s' %(frequencies[i],decibels[i]/count)

        return (frequencies,decibels/count)
```

CreateCSV.py

```
'''
Created on Jun 24, 2013
CreateCSV.py contains a class named CSVcreate, which contains methods
for creating various csv files from scratch in the current directory.
When making a CSVcreate object, you have to specify the 'db_file' and
the 'spec_file', so that it knows what raw data it has to look at.
Depending on the CSV method you choose, different types of decibel and
frequency files will be generated.
@author: Matt
'''
import csv
import datetime

debug = 0

class CSVcreate:

 #the constructor takes optional parameters for db and spec file locations
 def __init__(self,*args,**kwargs):
        self.dbFile = kwargs.get('db_file')
        self.specFile = kwargs.get('spec_file')

 #method for parsing the raw db File that grabs all of the timestamps and corresponding
 #dB level. If sample is set to true, it grabs a reading only every 5 minutes
 def db_CSV(self,dest_name,sample):

       if debug:
              print "Running db_CSV"

       #set up the CSV writer
       db_csv = open(dest_name,'wb')
       db_writer = csv.writer(db_csv,dialect='excel')

       #get the lines to be read, and the staring line, skips three lines because of the two
lines after # Broadband Log Results
       raw_lines, line_cnt = self.get_starting_line(self.dbFile,"# Broadband LOG Results",3)

       if debug:
              print "raw_lines length:", len(raw_lines)
              print "line_cnt:", line_cnt

       count = 0
       first = True
       beginCount = False
       timeStart = datetime.time(16,55,0)
       startDay = None

       #workingDay = None

       #begin looping through ever line starting at line_cnt
       for line in raw_lines[line_cnt:]:
              data_point = line.split()
              if len(data_point) > 1:

                     dayDate = data_point[0]+ ' '+ data_point[1]
```

```
                        year,month,day = dayDate.split(' ')[0].split('-')
                        hours,mins,secs = dayDate.split(' ')[1].split(':')

                        year = int(year)
                        month = int(month)
                        day = int(day)
                        hours = int(hours)
                        mins = int(mins)
                        secs = int(secs)

                        date = datetime.date(year,month,day)
                        time = datetime.time(hours,mins,secs)
                        current = datetime.datetime.combine(date,time)

                        #if has been 5 minutes and the user wants to sample
                        if mins%5 == 0 and sample:
                                #write the merged timestamp and decibel reading

                                if debug:
                                        print "Line to be written:", ([data_point[0]+ ' '+
data_point[1],data_point[3]])

                                db_writer.writerow([data_point[0]+ ' '+
data_point[1],data_point[3]])
                                count = 0
                        elif not sample:
                                db_writer.writerow([data_point[0]+ ' '+
data_point[1],data_point[3]])
                else:
                        print "count: ", count
                        break


        print "Decibel readings CSV File created with filename '%s'"%dest_name

 #grabs the already computed averages and the proper frequency labels from the raw frequency
file,
 #and writes them to a excel file for graphing.
 def spec_CSV(self,dest_name):

        #get the lines to be read and the starting line of the Hz Labels
        raw_lines,line_cnt = self.get_starting_line(self.specFile,"# RTA Results",1)

        all_vals=raw_lines[line_cnt].split()

        #get the Hz Labels and convert them to floats
        HZ_vals = all_vals[3:]
        for item in range(len(HZ_vals)):
                HZ_vals[item] = float(HZ_vals[item])
        print "Successfully converted Hz values"

        #get the next starting line where the frequency values begin
        raw_lines,line_cnt = self.get_starting_line(self.specFile,"# RTA Results",1)

        all_db_vals = raw_lines[line_cnt].split()
        intended_line = raw_lines[line_cnt+4].split()
```

```
        db_vals = intended_line[2:]

        #loop through converting each value to a float
        for item in range(len(db_vals)):
                if db_vals < 50:
                        db_vals[item] = float(db_vals[item])
        print "Successfully extracted Leq values"

        #prepare the CSV writer
        spec_csv = open(dest_name,'wb')
        spec_writer = csv.writer(spec_csv,dialect='excel')

        #write the HZ values and then write the corresponding decibel readings
        spec_writer.writerow(HZ_vals)
        spec_writer.writerow(db_vals)

        print "Finished creating CSV"
 #Grabs and writes all of the readings from the entire file, not just the averages
 def write_All_Spec(self,dest_name):

        #Get datestamp
        raw_lines,line_cnt = self.get_starting_line(self.specFile,"# Time",1)
        start_time = raw_lines[line_cnt].split()
        end_time = raw_lines[line_cnt+1].split()
        dateStamp = (start_time[1]+ ' '+ end_time[1])

        raw_lines,line_cnt = self.get_starting_line(self.specFile,"# RTA Results",3)
        reader = open(self.specFile).read().strip().split('\n')
        writer = csv.writer(open(dest_name,'wb'))
        counter = 0
        for row in reader:
                row = row.split()
                if (counter >=line_cnt and counter<=line_cnt+2) : #Only extract LZFMax,
LZFMin, and LZeq
                        if not row or len(row) < 35:
                                break
                        writer.writerow([dateStamp]+map(float,row[2:]))
                        counter +=1
                        print "added row"
                else:
                        counter +=1
        print "Finished writing all spec"
 #searches for a specific string (delimeter) in the input file, and returns
 #that line number, plus the amount of lines input for skipln
 def get_starting_line(self,file,delimeter,skipln):
         raw_db = open(file)
         raw_lines = raw_db.read().split('\n')
         line_cnt = 0
         for line in raw_lines:
                 if str(line) == delimeter:
                         print "done getting line!"
                         line_cnt += skipln
                         break;
                 line_cnt += 1
         return raw_lines,line_cnt
```

StitchingData.py

```
'''
Created on Jun 24, 2013
stitching_data stitches already created CSV files for seperate days into
one large seemless CSV file, with different options and methods useful for
graphing or calculating statistics on
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'''
import csv
import numpy
import os
import datetime

#Takes a new destination file name, a lineGap boolean, and a list
#of all the filenames to stitch togeteher.
#
#The boolean Linegap should be set as true if there is to be a linegap
#after each days worth of data, which makes graphing the overlay graphs
#much easier
def stitch(dest,lineGap,*filenames):
        first = True

        timeStart = datetime.time(17,0,0)
        timeEnd = datetime.time(16,59,59)

        stitch_csv = open(dest,'wb')
        writer = csv.writer(stitch_csv,dialect='excel')

        for count, file in enumerate(filenames):
                if os.path.exists(file):
                        csv_reader = csv.reader(open(file,'r'))
                        next_day = None
                        for row in csv_reader:
                                year,month,day = row[0].split(' ')[0].split('-')
                                hours,mins,secs = row[0].split(' ')[1].split(':')

                                #Convert all date data into ints
                                year = int(year)
                                month = int(month)
                                day = int(day)
                                hours = int(hours)
                                mins = int(mins)
                                secs = int(secs)
                                d = datetime.date(year,month,day)
                                t = datetime.time(hours,mins,secs)

                                dayDate = datetime.datetime.combine(d,t)

                                #get to first day of data starting at 1700
                                if lineGap:
                                        stamp = row[0].split(' ')[1]

                                if first == True:
                                        startDay = datetime.datetime.combine(d,timeStart)
                                        endDate = startDay + datetime.timedelta(days=1)
                                        nextDay = datetime.datetime.combine(endDate,timeEnd)
```

```
                                        first = False

                                    if dayDate >= startDay and dayDate < nextDay:
                                            if lineGap:
                                                    writer.writerow([stamp,row[1]])
                                            else:
                                                    writer.writerow(row)

                                    if dayDate >= nextDay:

                                            if lineGap:
                                                    writer.writerow('')

                                            startDay = datetime.datetime.combine(d,timeStart)

                                            endDate = startDay +
datetime.timedelta(days=1)#datetime.date(year,month,day+1)
                                            nextDay = datetime.datetime.combine(endDate,timeEnd)

                                            if lineGap:
                                                    writer.writerow([stamp,row[1]])
                                            else:
                                                    writer.writerow(row)
        print 'done appending averages'
#takes an existing destination CSV file and a window size, and
#calculates a moving average on the data
#
#window_size specifies how far ahead to look when calculating the moving
#average, and therefore how smooth the generated curve would be
def movingaverage(dest, window_size):
        data = csv.reader(open(dest,'r'))
        window= numpy.ones(int(window_size))/float(window_size)
        decibels = []
        for row in data:
                if row:
                        if len(row) == 2:
                                date = row[0]
                                db = row[1]
                                decibels.append(float(db))
        return numpy.convolve(decibels, window, 'same')
#Takes an existing destination that is already fully stitched
#and appends the moving average into a new column of the CSV File
def appendAverages(dest,window_size):

        #gets the list of averages to be appended
        averages = movingaverage(dest,window_size)
        counter = 0

        #prepare the CSV Writer
        avg_file = dest[0:-4] + '_moving_avg.csv'
        avg_writer = csv.writer(open(avg_file,'wb'))
        avg_reader = csv.reader(open(dest,'r'))

        for row in avg_reader:
                if row:
                        row.append(averages[counter]) #appends the average to this row
                        avg_writer.writerow(row)
```

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                counter += 1
            else:
                avg_writer.writerow('')
```