

BatME: Monitoring distribution and trends of bats in Maine using outreach-based citizen science - Final Report



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TABLE OF CONTENTS (Section headings are hyperlinked)

PROJECT SUMMARY	3
PROJECT BACKGROUND	4
SUMMARY OF OBJECTIVES AND HOW THEY WERE MET	6
APPROACH AND RESULTS	
<i>Volunteer Efforts.....</i>	<i>7</i>
<i>Detector Field Validation.....</i>	<i>13</i>
<i>Caveats to Call Interpretation</i>	<i>15</i>
<i>Focus Group Meeting.....</i>	<i>15</i>
CONCLUSIONS:	
<i>What worked well.....</i>	<i>16</i>
<i>Limitations that were encountered.....</i>	<i>17</i>
<i>Future objectives:.....</i>	<i>19</i>
ADDITIONAL FUNDING APPLIED FOR:.....	19
PROJECT PRODUCTS	19
ACKNOWLEDGEMENTS.....	21
APPENDICES:	
Appendix 1. BatME Data Collection Protocols (Year 1)	
Appendix 2 - BatME Data Collection Protocols (Year 2)	
Appendix 3 – BatME Data Downloading Protocols	
Appendix 4 – BatME Paired Survey Protocols	

PROJECT SUMMARY

Bats are a poorly understood component of many ecosystems but are critically important for the roles they play in ecological food webs and the resulting insect pest control services they provide. In the northeastern U.S., a fungal that produces a disease commonly referred to as White-Nose Syndrome (WNS) has resulted in unprecedented declines of cave-hibernating bats, with some species experiencing population losses in excess of 90%. Maine is home to eight species of bats, and bat deaths associated with WNS were first detected in the state in 2011. Three species of bats are currently protected as state threatened or endangered, and one species of bat in Maine is federally protected as threatened under the US Endangered Species Act. Despite these significant concerns, no formal statewide monitoring program exists for bat populations in Maine. In 2015 we initiated a pilot bat monitoring program – BatME – to test the feasibility of using citizen scientists and handheld acoustic detectors to monitor bat occurrence in Maine. Through a grant from the Maine Outdoor Heritage Fund we purchased a small number of handheld bat detecting units and enlisted the help of volunteers to field test the units during July – September 2015, and May – September 2016. Sixteen volunteers conducted 85 nightly surveys during 2015, and 12 volunteers conducted 82 nightly surveys during 2016. When combined with data collected by project personnel as part of equipment and protocol testing, we recorded over 9,300 bat observations, detected 7 of Maine’s 8 bat species, and recorded bat presence in 94 towns. After data processing, error associated with noise (i.e. noise incorrectly identified as a bat) was less than 1.0% however species classification shares the same potential error common to all acoustic monitoring. We also evaluated the utility of tablet-based detectors for conducting stationary and driving bat acoustic surveys, and found that they collected data of similar or greater quality to alternative acoustic detectors. During February 2015 we conducted a 1-day focus group workshop to reflect on experiences during the 2015 field season, to identify areas of project improvement, and to discuss options of expanding the program into the future. We established a series of formal protocols for data collection and download, a project website, and a mechanism for online data entry and download. We conclude with our assessment of the potential for citizen science as a tool for bat population monitoring, including the challenges and limitations we experienced during this

project, and a statement of what is required for BatME to expand and become a long-term tool for bat monitoring in Maine.

PROJECT BACKGROUND

Maine is home to eight bat species, including northern long-eared bat (*Myotis septentrionalis*), little brown bat (*Myotis lucifugus*), eastern small-footed bat (*Myotis leibii*), tricolored bat (*Perimyotis subflavus*), big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*). White-nose syndrome (hereafter WNS) is caused by a fungal pathogen and affects cave-hibernating bats. The disease was first identified in New York in 2006 (Blehert et al. 2009) and spread rapidly throughout the Northeast, reaching Oxford County Maine in 2011. WNS has resulted in unprecedented declines in bat populations throughout the eastern U.S., with some species experiencing a 90% population decline over the last five years. This, coupled with other conservation concerns, such as bat mortality at wind power facilities, has increased the interest in and need for effective strategies to monitor bat populations.

Citizen science programs that enlist the help of volunteers to collect scientific data can be effective tools for large-scale wildlife monitoring. The Christmas Bird Count for North American birds ([CBC web link](#)) is one such program. Birds are distinctly colored and relatively easy to identify by sight or sound. In contrast bats are not vocal, are mostly active at night, and are drably colored and difficult to identify even when in hand. These differences have traditionally presented a challenge to citizen-science collection of bat population data.

Acoustic recording has become a standard tool for bat monitoring (O'Farrell and Gannon 1999). Bats emit echolocation calls in the ultrasonic range, which cannot normally be heard by human ears but that can be recorded using specialized microphones and recording devices, which we will refer to generally as bat detectors. Characteristics of echolocation calls, such as their frequency and amplitude, differ among bat species (Fig. 1). This means that ultrasonic recordings of bat calls can be used to not only determine that a bat was present, but the calls can also be used to identify which species was present.

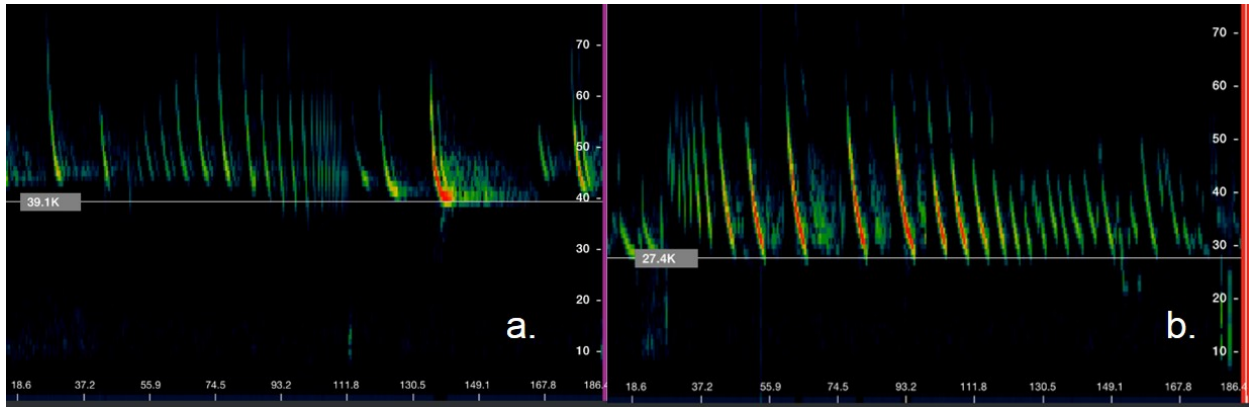


Figure 1. Two example sonograms of bat echolocation calls. Panel a. shows a call series from a little brown bat, whereas panel b. shows a lower frequency call series recorded from a big brown bat.

Traditionally, bat detectors have been relatively large instruments designed to be set in a fixed location to passively record bats for extended periods of time. More recently detectors have been developed that integrate ultrasonic microphones with mobile devices (e.g. a mobile phone or tablet). This hardware system is coupled with a software “App” that provides the computing power necessary to record, store, and interpret the bat echolocation calls. The result is a mobile bat detection package (Fig. 2) that is easy to use and provides attractive and accessible real-time outputs of bat detections and on-the-fly species identification. The software stores an audio recording of the bat calls for future use, and records call locations using the GPS chip from within the mobile device.

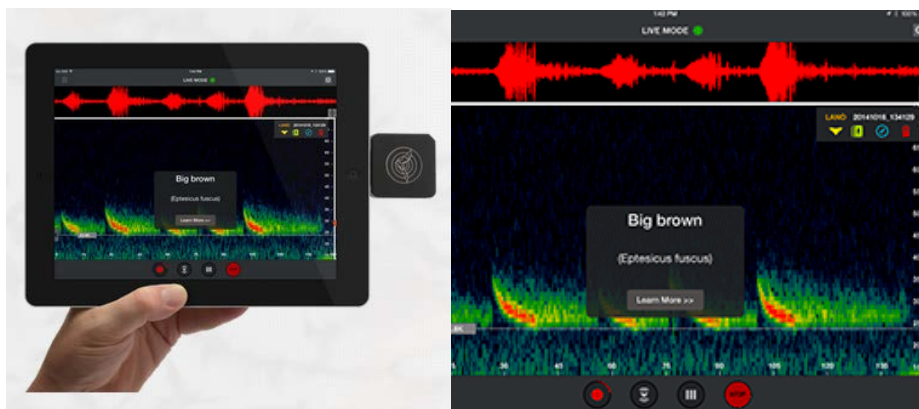


Figure 2. Wildlife Acoustics Echo Meter Touch bat detector and Echo Meter app (left), with example spectrogram and species identification tool (right).

In 2015 we initiated a pilot project – BatME – to develop citizen-science approaches for monitoring bat populations in Maine using tablet-based acoustic detectors. Our pilot field season in 2015 centered on testing the utility of tablet-based acoustic detectors and in assessing the ability of trained volunteers to collect bat occurrence data using the tablet-based detectors. We followed this in 2016 with a second season designed to collect data under a repeated sampling framework to evaluate site occupancy while accounting for imperfect detection. This work was funded by the Maine Outdoor Heritage Fund ([web link](#)).

SUMMARY OF OBJECTIVES AND HOW THEY WERE MET

Our major goal for this research was to develop an approach for broad-scale citizen science monitoring of Maine’s bats that would double as a tool for conducting outreach on bat conservation. Below we review our specific objectives for the work and give a brief summary of how each objective was met. Greater detail on how we met project objectives is provided throughout the remainder of the report, and can be accessed via the hyperlinks that are highlighted in blue.

1. *Evaluate the utility of handheld bat detectors for monitoring bat distributions in Maine by enlisting the help of citizen scientists.* During two summers we enlisted the help of more than 20 volunteers to test equipment and collect bat acoustic data. Volunteers reported that our detector packages were easy to use and nearly all were successful in detecting bats. We also conducted field testing that showed tablet-based detectors produced comparable data to stationary detectors. However, we also found that volunteers only reliably collected data on 6 of Maine’s 8 species of bats; two species (northern long-eared and eastern small-footed bats) were not regularly encountered. [We provide a summary of these results.](#)
2. *Develop appropriate sampling designs that can couple citizen science data with robust methods for data analysis and modelling.* Following our pilot field season, we developed a sampling protocol that integrated multi-survey occupancy models with citizen science data collection ([Appendix 2](#)). This approach would allow us to evaluate both the probability that a bat species occupied a particular site, and the probability that we would detect the species, given that the site was occupied.

3. *Through use of a focus group, develop a plan to expand BatME into a statewide program, and develop plans to integrate education and outreach components into BatME.* We conducted [our focus group meeting](#) on February 16th, 2016, and the group was instrumental in helping us to assess what worked and what could be improved from our first field season. We also found that a lot of education and outreach precipitated organically from the project; both in terms of requests of project staff to give presentations and interviews, and through both formal and informal activities conducted by volunteers while they had access to a BatME detector. Dedicated funding to support a project director could improve the ability to regularly conduct outreach and education. Education and outreach events that were conducted during the project are summarized [in our Products section](#).
4. *Identify additional sources of external funding (e.g. National Science Foundation) that could be used to scale up BatME in the future.* We submitted [a proposal](#) to the Maine Department of Inland Fisheries and Wildlife for funds to support additional work on the project and expansion to a long-term, statewide effort. Unfortunately, MDIFW was unable to accommodate our funding request, and we have been unable to secure any alternative sources of funds.

APPROACH AND RESULTS

Volunteer Efforts

During summer 2015 and 2016 we involved volunteers in bat data collection in two ways. First, we recruited a small number of volunteers with previous bat monitoring experience to assist with field testing of our detectors and general data collection during July – September 2015 and June – September 2016. Second, we partnered with [Maine Audubon](#) during both years to recruit members of the general public with an interest in bat conservation but without the expectation of prior experience. We held a 2-hour training workshop at the Gilsland Farm Audubon Center in July 2015, and volunteers signed up to check out detector packages for 1-week periods during August and September 2015. Some of these same volunteers also participated during 2016. BatME detector packages (Fig. 3) consisted of a Wildlife Acoustics Echo Meter Touch (EMT)

acoustic microphone ([web link](#)), an iPad Mini2 3G ([web link](#)), a Griffin Technologies Survivor protective case ([web link](#)), a CableJive extension cable ([web link](#)), and a carrying case. iPads were equipped with Wildlife Acoustic's Echo Meter App ([web link](#)), which provides both the software needed to collect and record bat echolocations that are picked up by the EMT microphone, as well as a graphical user interface. Each volunteer was also provided with a printed set of survey protocols, a data collection sheet, and a questionnaire (2015 only; see [Appendix 1](#)). Briefly, we asked volunteers to begin surveys approximately 15 minutes after sunset, to record for at least 30 minutes, and to conduct at least 2-3 nightly surveys during each week a detector was checked out. Survey protocols also provided guidelines for where to survey, instructions for detector operation, considerations for weather and noise, and directions for reviewing calls after surveys were completed. During 2016, we asked volunteers to return to repeat surveys at each location during at least two evenings within a 1-week period which allows data to be analyzed in an occupancy modelling framework (See [Appendix 2](#)).

Figure 3. BatME detector kit. The iPad Mini is also depicting a representative screen shot from the EchoMeter App.



During 2015, 16 BatME volunteers conducted 85 total nightly surveys during July, August, and September, for an average of 4 survey nights per volunteer (Range 1 – 17 nightly surveys). Survey time totaled 53 hours, and the average length of a single survey was 1.3 hours (range 0.3 to 6.0 hours). Volunteers reported detecting bats on 92% of surveys, although they only observed bats visually (e.g. flying at dusk) during 55% of surveys. We combined recordings collected by volunteers with field validation surveys (see below) and equipment testing conducted by E. Blomberg and C. Mosby, which yielded 5,038 bat call recordings collected during the summer of 2015. We used Kaleidoscope Professional Software ([web link](#)) to filter noise files and analyze species identification, which yielded 4,401 individual calls of sufficient quality for species ID. These calls represented 6 of Maine's 8 species of bats (Fig. 4). In total we collected bat data from 60 individual towns in Maine that were located in 15 of Maine's 16 counties (Fig. 5).

During 2016, 12 volunteers conducted 82 nightly surveys across 29 Maine towns. We conducted repeated surveys with at least two visits to a single site within a 1-week period at 29 different locations. Volunteers also conducted 5 driving transect surveys. When data from volunteer surveys, driving transects, and survey protocol testing by BatME personnel were combined, we collected 4,922 detections of bats with sufficient quality for species identification, which represented 7 of Maine's 8 species. The majority of these were either big brown bats or one of the state's three species of migratory tree bats (Fig. 4). However, we also detected one eastern small-footed bat and a substantive number of little brown bats and tri-colored bats. Across both seasons, volunteers consistently encountered both little brown bats and tri-colored Bats (Fig. 6), which may suggest that citizen-science projects are well-suited for detecting and monitoring these two high-profile species. In contrast, we rarely and never encountered eastern small-footed and northern long-eared bats, respectively. Some calls were identified as northern long-eared bats by the EchoMeter Touch App, and were also classified as such by Kaleidoscope Pro software, but when we hand-vetted these calls based on standard criteria to conclusively identify a northern long-eared bat, we determined them to be misclassifications. Therefore we suggest that stationary acoustic detectors are likely a better tool for monitoring rare and difficult to detect species.

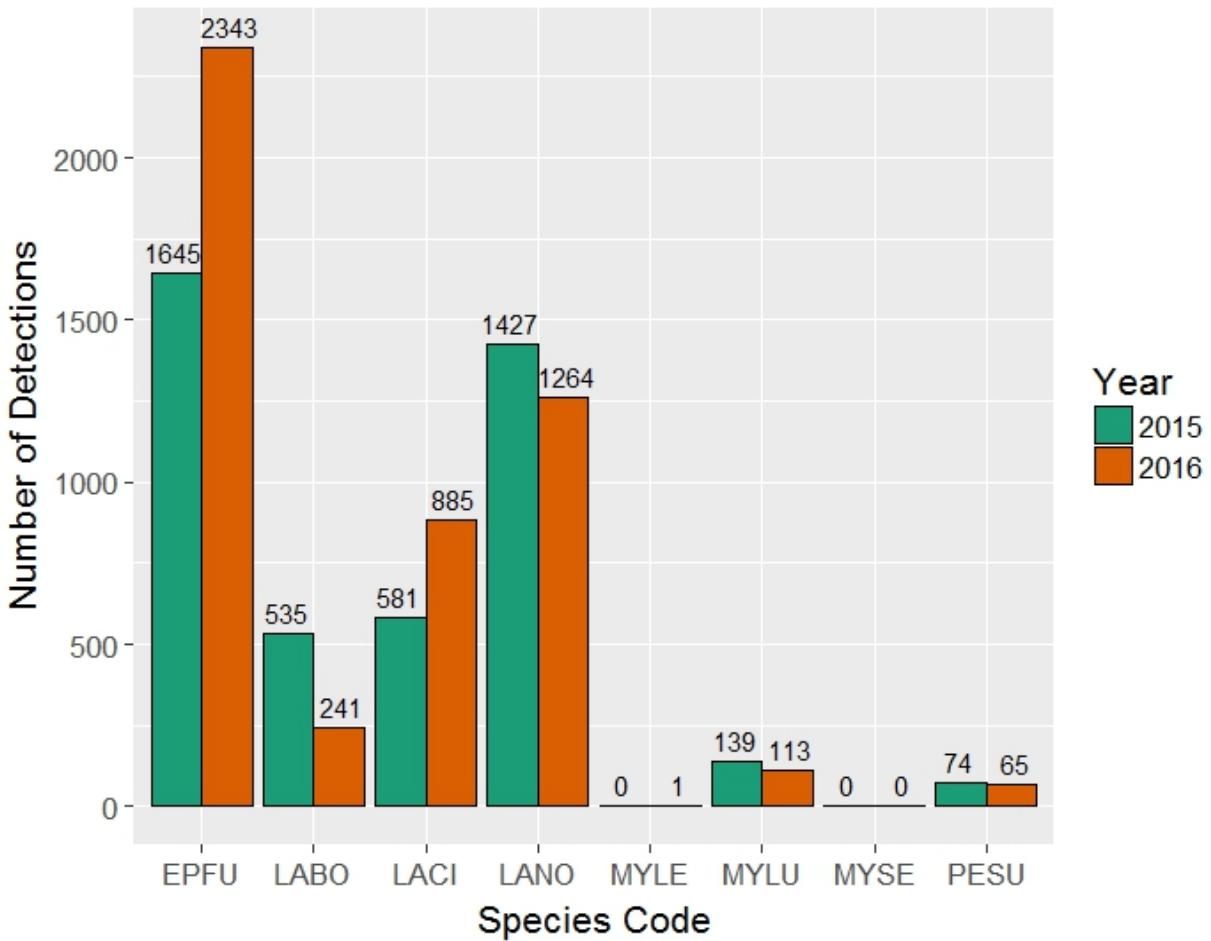


Figure 4. Summary of bat recordings collected, by species, by the BatME project during summer 2015 and 2016. One detection consists of a single recording of a species. Often multiple detections were logged in a single location, so these numbers do not represent independent observations. Species codes are as follows: EPFU = Big Brown Bat; LABO = Eastern Red Bat; LACI = Hoary Bat; LANO = Silver-haired Bat; MYLE = Eastern Small-footed Bat; MYLU = Little Brown Bat; PESU = Tricolored Bat. See our caveat below related to call classification accuracy.

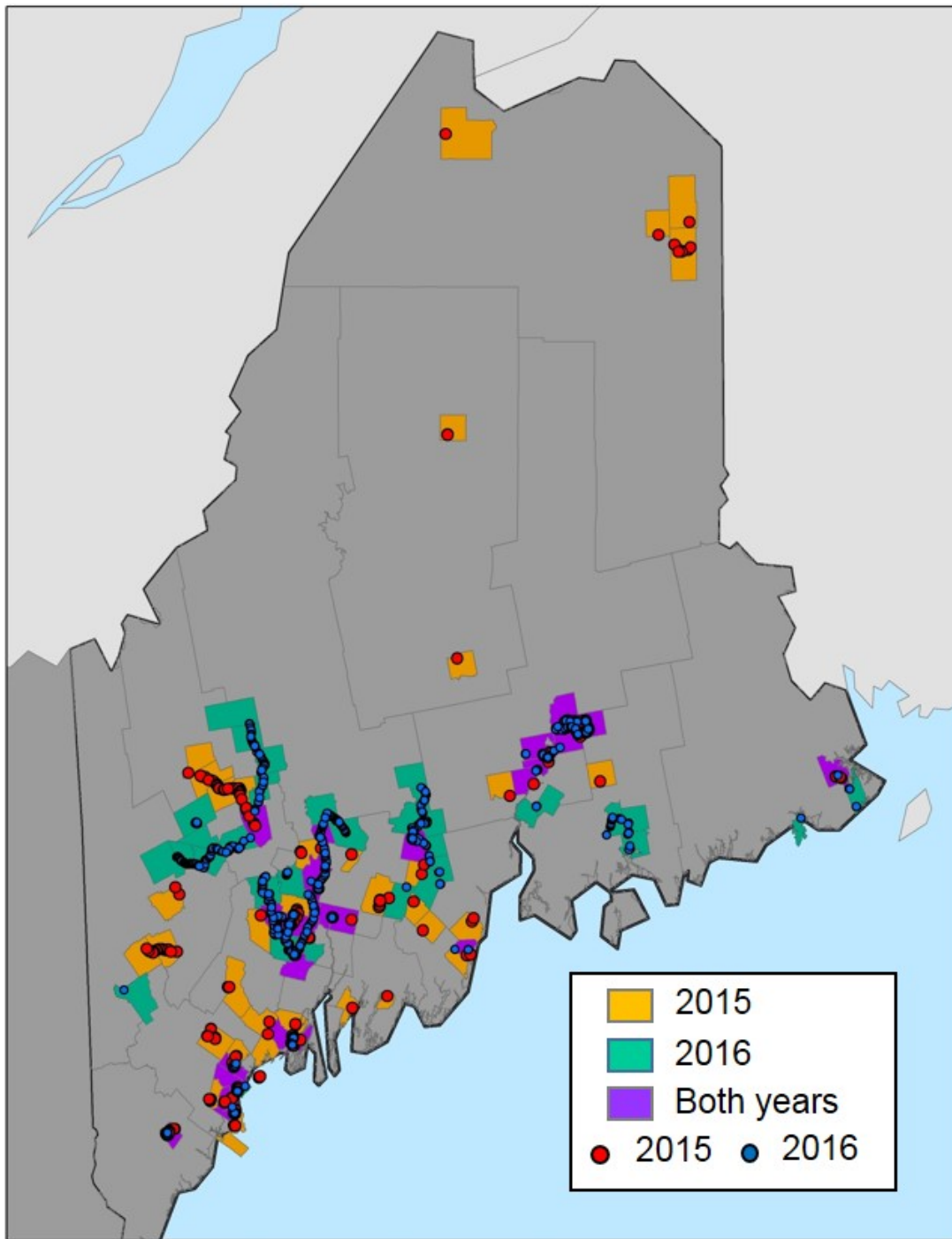


Figure 5. Locations of bat call recordings collected by the BatME project during summer 2015 (red dots) and 2016 (blue dots). Towns where bats were detected are also shown, colored by year. Because multiple recordings are often collected in a single location, there is typically a large degree of overlap in the number of files recorded at any single location.

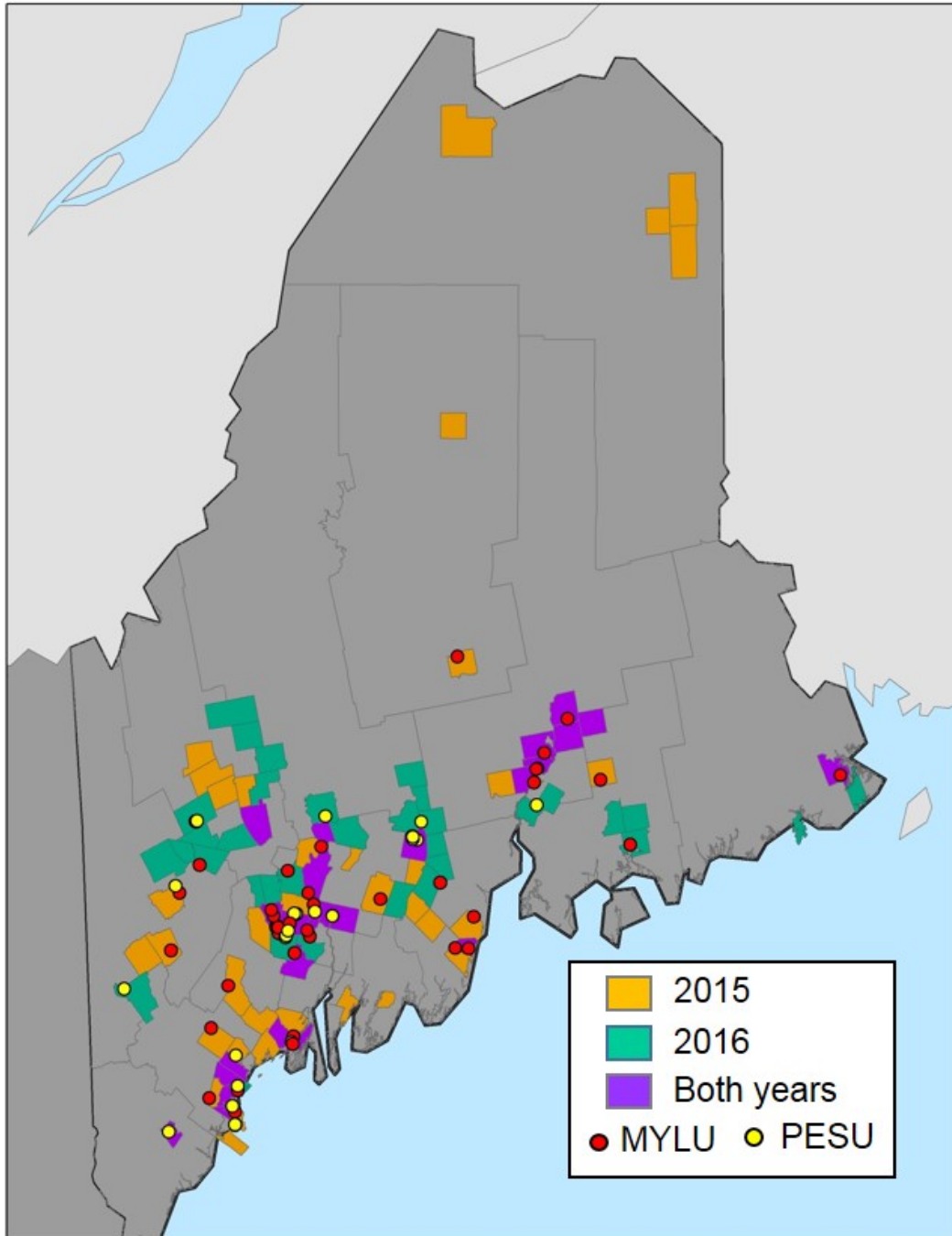


Figure 6. Locations of bat call recordings of two species of concern: little brown bats (MYLU; red dots) and tri-colored bats (PESU; yellow dots) collected by the BatME project during 2015 and 2016. Towns where bats of any species were detected are also shown, colored by year for comparison. Because multiple recordings are often collected in a single location, there is typically a large degree of overlap in the number of files recorded at any single location.

Detector Field Validation

In addition to the volunteer surveys described above, we also conducted a number of field validations of our tablet-based detectors to evaluate their utility in comparison to other, more widely used acoustic detectors. First, we conducted paired surveys with an EMT/iPad detector positioned alongside a Wildlife Acoustic SongMeter SM3BAT. In this test, detector microphones were placed side-by-side at a height 1.5 meters above the ground and both units were allowed to run between 1-3 hours. We conducted this test in a residential neighborhood during early July, and repeated the sampling on 3 consecutive nights with clear conditions. Each detector detected and classified presence of three bat species: big brown bats, hoary bats, and silver-haired bats. The EMT/iPad detector 30% more bat recordings overall, and within individual recordings (passes by a single bat) detected a larger number of calls (pulses; Fig. 7). This suggests that the EMT microphone and iPad collect comparable data when placed in a common environment.

Second, we explored the utility of the EMT/iPad detectors for conducting vehicle-based mobile surveys, which are commonly used to survey bat abundance. Here, we conducted a side-by-side test of the EMT/iPad detector with a Wildlife Acoustics EchoMeter EM3+ mobile detector. Here, we conducted a driving survey following standard protocols by driving at 20 mph along a 16 mile transect with both detector microphones mounted together approximately 0.2 meters above the roof of the vehicle. Here, the EMT/iPad unit recorded a greater number of individual bats, a greater number of individual calls, and recorded less ambient noise than the EM3+ (Fig. 8). These results suggest that the EMT/iPad detectors are useful tools for mobile bat surveys.

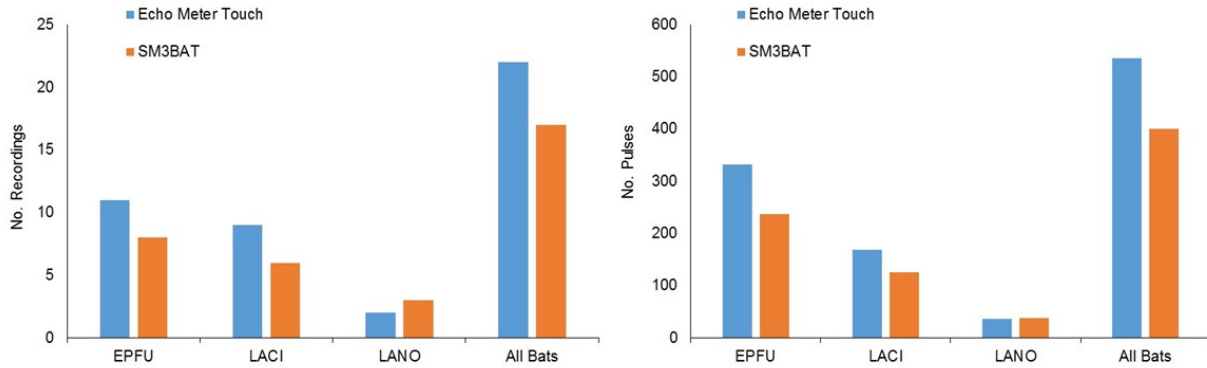


Figure 7. Side-by-side comparison of the EMT/iPad and Song Meter SM3Bat acoustic recorders for total number of bat passes recorded (left panel) and number of calls (pulses) per recording. Bat species codes are: EPFU = big brown bat; LACI = hoary bat; LANO = silver-haired bat

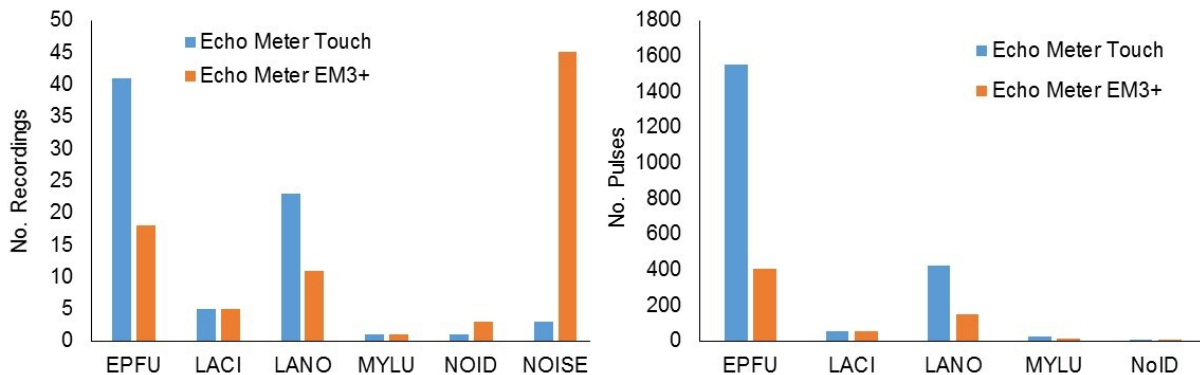


Figure 8. Side-by-side comparison of the EMT/iPad and Echo Meter SM3+ acoustic recorders during a driving transect for total number of bat passes recorded (left panel) and number of calls (pulses) per recording. Bat species codes are: EPFU = big brown bat; LACI = hoary bat; LANO = silver-haired bat; MYLU = little brown bat; NOID = bat ID could not be determined; NOISE = non-bat noise files.

Caveats to Call Interpretation

It is important to note that interpreting bat calls and identifying species based on acoustic files can be challenging, because substantial overlap often exists among species depending on a number of factors. For example, silver-haired bats and big brown bats are known to have very similar call structures, so it is likely that many of the bats identified as silver-haired in Figure 4 may have been big brown bats, which are generally believed to be more common. As such our results related to species identification should be viewed cautiously. By individually vetting a subset of calls, however, we know that volunteers regularly detected little brown bats and tri-colored bats. These two species have been impacted by WNS and little brown bats are listed under the Maine Endangered Species Act as endangered. We also vetted a large subset of calls (>2,000) to assess how frequently ambient noise was recorded and misclassified as a bat after data processing. We found that noise misclassification rates were <1%, suggesting that any noise associated with active surveys (e.g. walking through grass or other ambient noises) was effectively filtered by the detector, the post-processing of data, or a combination of both.

Issues of call misclassification are common to all bat acoustic monitoring and are in no way unique to our project or citizen-science data collection in general. The consequence of call misclassification to results and conclusions from bat monitoring depend largely on the goals and objectives of a particular project. Hand-vetting of all calls is time-consuming and requires a fair deal of experience, but may be necessary in some situations (e.g. to document the definitive presence of a bat at a site). Trends in the proportion of sites occupied may be less-sensitive to this issue, if the rate of call misclassification by species remains relatively constant through time or across space. For citizen-science projects, it is important to acknowledge issues of call classifications when training volunteers, so that they are aware of the uncertainty inherent to the species identifications they obtain during surveys.

Focus Group Meeting

On February 2nd we held a focus group meeting attended by 8 participants, including representatives from the University of Maine, Maine Department of Inland Fisheries and Wildlife, Maine Audubon, and four project volunteers. Discussion focused

on a summary of results from our pilot field season, practical lessons learned during the first year, and a host of topics centered on project development and future directions. Some of the biggest practical challenges during the first year that were identified had to do with the logistics of distributing detectors and downloading and storing data, and we brainstormed and discussed ideas to streamline that process. The group collectively agreed that the pilot season had been successful as a whole and that the project was worth expanding and incorporating as a bat population monitoring tool in Maine.

CONCLUSIONS:

What worked well

1. Tablet-based bat detectors are clearly an excellent tool for bat education and outreach. In addition to being useful for allowing people to detect bats in the nighttime environment, tablets with pre-recorded call files were very helpful for daytime outreach events.
2. We found that the hardware (EchoMeter Touch, iPad Mini) and software (EMT App) were very user friendly and that volunteers were able to use them successfully with a small amount of training.
3. Volunteer citizen scientists successfully collected data on common bat species (big brown bat and migratory tree bats). These species aren't typically affected by WNS, and thus are of lower conservation concern than those species which are, however, they remain the most abundant bat species in Maine and are thus providing the bulk of ecological services (e.g. insect pest control) commonly associated with bats. Moreover, migratory tree bats are of particular concern because of mortality associated with wind turbines. Citizen science projects using mobile detectors are likely well-suited for monitoring this segment of Maine's bat community.
4. We also found that tablet-based surveys regularly detected little brown bats and tri-colored bats; both species of concern in Maine due to threats imposed by WNS. These results suggest that mobile detectors and citizen scientists could be well-suited for monitoring these two species. Little brown bats were likely the most common species in Maine prior to WNS, and along with big brown bats are most

commonly associated with humans because of their tendency to roost in manmade structures. Tri-colored bats are perhaps the least well-understood bat species in Maine, and better understanding their status and distribution would provide some seminal information about the species in the state.

5. We found that two general approaches for engaging volunteers were useful for data collection: the first was a group-based approach based on detector checkout from a centralized hub, and the second an individualized approach where extremely dedicated volunteers were loaned detectors for longer periods. The group-based approach should work well for collecting data across a broad spatial extent (i.e. statewide), and engaging the largest number of volunteers. The second, individual-based approach was very useful for working with biologists to collect data in targeted areas, in particular for completing road-based surveys using the EMT/iPad detector.

Limitations that were encountered

1. The biggest logistic issue that we encountered during the project, by far, was related to data retrieval and management. During the two years of our project we generated nearly 100 gb of acoustic data, comprised entirely of individual bat call files. During a scaled-up, statewide citizen science project we expect the volume of data collected on a year to year basis could be as much as 5 times that amount. All of this data must be individually downloaded from each detector, stored and organized, and also linked to ancillary data collected by volunteers during their surveys such as survey timing and distance covered. Some of this is inherently captured by the GPS coordinates and timestamps of the individual bat calls, but this information is not available for surveys or times in which no bats were detected, and information on non-detection is equally important for population monitoring. For this reason we developed survey forms and protocols for volunteers to record survey-specific data, and a web-form for those data to be entered and uploaded to a central database ([Appendix 2](#)). Ultimately the data collected during surveys is only useful if it is processed to identify bat species, analyzed to detect trends, and presented in the form of annual reports, public and conference presentations, and

peer-reviewed journal articles, and all of this (particularly the call identification and analysis) take significant amounts of time. Moreover, we felt that regular communication was crucial for keeping volunteers active and engaged in data collection. This came in the form of an initial training session, period emails to check in on people's experiences in the field, and relaying results of each year's efforts in a timely fashion. Thus the total time commitment required for both engaging with volunteers and managing data was substantive.

2. Dedicated staff time for project coordination, data management, outreach, and analysis needs to accompany any large-scale bat monitoring project, and one conducted with citizen scientists is no exception. We anticipate that a large-scale citizen science project based off the BatME model could easily require a 50% position (i.e. 0.5 FTE) throughout the year. Inability to secure sufficient funding to support staff time was an impediment to further development of this project, and that limitation will need to be overcome if the project is to continue in the future.
3. We did not reliably detect northern long-eared bats or eastern small-footed bats during any surveys associated with this project, which suggests that these two species may be ill-suited for monitoring using tablet-based detectors. These are both species of high conservation concern, and northern long-eared bats are of particular concern because of their status as a threatened species under the US Endangered Species Act. We believe reasons for lack of detection for these species during our project are two-fold. First, they are the rarest among Maine's bats and are therefore simply less likely to be detected by all acoustic methods. Second, volunteers were probably less likely to survey the specialized habitat used by these two species, which are typically found in areas of closed canopy forest and, in the case of eastern small-footed bats, around rocky outcroppings and talus slopes. Targeted surveys by citizen scientists, in consultation with biologists, could increase the likelihood of detection, however, traditional acoustic monitoring using stationary acoustic detectors may ultimately be better-suited for these two species.

Future objectives:

At present we lack funding to continue the project. We will continue to explore funding opportunities, and will resume data collection and bat monitoring if and when additional funding is secured. In the interim, we will use the equipment purchased with MOHF funds for education and outreach events, and will also make detectors available to MDIFW for conducting driving transect surveys.

We will continue to explore the data we collected during 2015 and 2016, and are considering publication of two peer-reviewed manuscripts. The first would present our approach to citizen-science bat monitoring and present some of our results and field validations. Our hope would be that this paper could assist others as they develop bat citizen science projects. We may also consider writing a paper that explores the data we collected on tri-colored and little brown bats, as these are Maine species of concern and better-understanding the factors that affect their summer distribution could inform bat conservation in the state.

ADDITIONAL FUNDING APPLIED FOR:

1. BatME: Monitoring distribution and trends of bats in Maine using outreach-based citizen science. Maine Department of Inland Fisheries and Wildlife. \$72,016.
Unsuccessful.

PROJECT PRODUCTS

The Maine Outdoor Heritage Fund was acknowledged in all project outputs – including press releases and media coverage.

Press Release:

1. *Blomberg seeks to increase awareness, monitoring of declining bat populations in Maine.* University of Maine Press Release, 5 November 2015. ([web link](#))

Media Coverage:

1. *Maine Public monitors bats with mobile devices.* Bangor Daily News, November 19th, 2015. ([web link](#))
2. *Volunteers count bats in Maine in an effort to save them.* Maine Public Broadcast Network, August 7th 2015. ([web link](#))

Conference Presentations:

1. Morano, S., E. J. Blomberg, and C. Mosby. Monitoring bat populations in Maine: new strategies for citizen science data collection. Poster. The Wildlife Society Annual Conference, Raleigh, NC. October 2016.
2. Morano, S., E. J. Blomberg, and C. Mosby. Monitoring bat populations in Maine: new strategies for citizen science data collection. Poster. International Bat Research Symposium, Winter Harbor, ME, April 2016.
3. Blomberg, E. J., S. Morano, and C. Mosby. Monitoring bat populations in Maine: new strategies for citizen science data collection. Oral Presentation. Northeast Bat Working Group Symposium. Baltimore, MD, January 2016.

Outreach:

1. Conducted two bat walks at the Orono Bog Boardwalk and Bangor City Forest, Bangor/Orono ME, July 2016.
2. Delivered an invited presentation and conducted a bat walk with the Penobscot Valley Chapter of Maine Audubon, Orrington, ME, July 2016.
3. *Monitoring bat populations in Maine: New strategies for citizen-science data monitoring.* Invited lecture for Friends of Dr. Edith Marion Patch Seminar Series. October 2015.
4. Presented and discussed bat acoustic monitoring with a group of 5 Wabanaki High School Students participating in the Wabanaki Youth in Science (WaYS) program. July 2015.

Web Pages:

We purchased the domain name and created a project web page batme.org. We used this webpage to disseminate information about the project, solicit volunteers, and host web forms that we used to collect data about survey sites.

Protocols and Instructional Materials:

Copies of all materials are attached as appendices to this report.

1. BatME: Citizen Science Bat Monitoring in Maine – Year 1 Protocols. (Blomberg, E.J., and S. Morano) General project protocols, including background information on bats and acoustic monitoring, instructions for conducting surveys, use and care of detectors, data collection form and questionnaire. **Attached as Appendix 1.**
2. BatME: Citizen Science Bat Monitoring in Maine – Year 2 Protocols. (Blomberg, E.J., and S. Morano) Similar to year 1 protocols but include additional details and instructions for conducting repeated surveys. **Attached as Appendix 2.**
3. BatME: Data Downloading Protocols. (Blomber, E.J) List of instructions for downloading bat acoustic files from iPads and uploading those files to our Google Drive online call database. 4 pages. **Attached as Appendix 3.**
4. BatME: Paired Survey Protocols. (Blomberg, E.J. and C. Mosby) Set of instructions for setting a stationary detector to serve as a comparison for evaluating tablet-based surveys. **Attached as Appendix 4.**

ACKNOWLEDGEMENTS

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Appendix 1. BatME Data Collection Protocols (Year 1)

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Overview: Recent declines in bat populations throughout the Northeast have generated concern over bat conservation. Bats are a critically important but poorly understood species in many ecosystems, and Maine is no exception. Bats may provide literally billions of dollars of ecological services in the form of insect pest control. White-nose bat syndrome (WNS), is a fungal pathogen that affects cave-hibernating bats, was first identified in New York in 2006, and has spread rapidly throughout the Northeast, reaching Oxford County Maine in 2011. WNS has resulted in unprecedented declines in populations of cave-hibernating bats, with some species experiencing a 90% population decline over the last five years. These declines have prompted considerable interest in better understanding the distribution and abundance of bats in Maine and elsewhere.

Bats emit high-frequency calls that they use for echolocation while flying and feeding. These calls are ultrasonic and are generally not audible to human ears, but they can be recorded using specialized acoustic monitoring equipment. Importantly, echolocation calls can also be used to distinguish among different species of bats. Researchers from the University of Maine Department of Wildlife, Fisheries, and Conservation Biology, in collaboration with the Maine Department of Inland Fisheries and Wildlife, are exploring the use of handheld bat acoustic detectors to serve as tools for citizen scientists to collect data on bat distributions in Maine. We are seeking volunteers to help test detectors and provide feedback on their use and potential for future monitoring programs. Detector units consist of an ultrasonic microphone (smaller than a deck of cards) attached to an Apple iPad mini. The microphone interfaces with an “App” on the tablet that interprets and displays bat calls as they are detected. We would like to recruit volunteers to assist with testing these devices by conducting bat surveys in Maine this summer. We will provide instructions for use of the detectors during a “hands-on” training session, then participants will be able to check out the detector from Maine Audubon and conduct surveys throughout the summer. We will ask that participants provide written feedback to document their experience, which we will use to inform future efforts.

This work is supported by a grant from the Maine Outdoor Heritage Fund (<http://www.maine.gov/ifw/MOHF.html>).

Conducting bat surveys:

Once you've checked out a detector, we ask that you conduct at least 2-3 evening surveys. We are interested in recording all species of bats wherever they occur, so the particular location of where you conduct your surveys is not terribly important. As a good first step, if there are areas where you've noticed bats flying around in the evenings, like along your street, at a local park or natural area, or even in your back yard, those would be great places to start. Many bats are attracted to open areas, like

yards, fields, or meadows, and because they eat insects, they are also likely to be found in "buggy" places, like wetlands, ponds, or along streams and rivers. These are all great places to search.

Bats begin their nightly activity during the twilight period just after sunset. While you are welcome to conduct surveys at any time of night, we suggest that you begin recording approximately 15 minutes after sunset. We also ask that you attempt to record bat calls for at least 30 minutes during any evening that you attempt a survey (but feel free to stay out longer than 30 minutes, if you like). Bats will be most active on calm, clear evenings, and detecting them in the rain is particularly difficult, so you should try to target evenings when there is no rain and when the wind is less than 10-15 mph (a light breeze or less).

After you've selected your location and started your survey, you should decide whether you want to survey actively, by moving around to different locations, or passively by staying put for the entire 30+ minutes while you are out. Both options have advantages and disadvantages. In an active survey, you will cover more ground and potentially encounter more bats in different places. This might make good sense if you are surveying a park, or walking through your neighborhood. The disadvantage is that the act of walking will create noise (see below) that the detector may pick up and that may mask bat calls, so the best approach is probably a hybrid where you walk slowly and stop periodically in likely looking places and wait to see if you record activity. If you happen to see a bat flying at twilight, trying to approach it in order to get calls is a great option, too. Walking along hard surfaces, such as pavement or gravel, produces less ultrasonic noise than walking through grass or other vegetation.

During passive surveys, which may be more practical if you are surveying your backyard or along a lake shore, you might cover less area but will survey a particular point more thoroughly and will introduce less noise to the detector. Sitting in a lawn chair sipping a beverage while the detector records passing bats is also perfectly acceptable approach to collecting bat calls. Please record on the data sheet for each survey whether you took an active vs passive approach to your survey.

Using the handheld detector:

The detector unit consists of a Wildlife Acoustics Echo Meter Touch acoustic microphone connected to an Apple iPad mini2. The microphone is needed to pick up the ultrasonic calls of bats, which are generally in a much higher pitch than a standard microphone (or the human ear) can detect. Calls are interpreted by the Echo Meter app on the iPad, which takes advantage of the iPad's computing power to record and analyze the incoming bat calls and display them in a way that is interpretable to us. The app will display the bat calls as a colorful spectrogram (a graphical depiction of a sound) and will translate the ultrasonic calls of the bats into a near-sonic sound that our ears can detect, which will sound similar to a chirping bird. Once a series of calls has finished, and if the call was of sufficient quality, the detector will also produce an

"AutoID" estimate of what bat species was making the call (but see our caveat about the AutoID accuracy below). The detector will record the sound file, and will georeference the call's location using the iPad's GPS.

When beginning a survey, please follow these steps:

1. Plug the EchoMeter Touch microphone into the lightning port of the iPad. The iPad should pop up a small window asking if you would like to access the Echo Meter app, and you can click yes.
2. The opening screen will ask if you would like to start live mode, and you can press the large green button to do so. This will activate the recording screen.
3. Once live mode has started, you should see a scrolling screen with changing colors as the screen scrolls. If the screen is not in motion, tap the small button with three vertical lines at the bottom of the screen; this will change the speed at which sounds are displayed to real time.
4. You also should hear some sort of static-like noise in the background; if you do not, first tap the small bat icon at the bottom of the screen. If you still do not hear anything, check to make sure the iPad speakers are turned on and that the volume is up.
5. Once the detector is in live mode, it will pick up and display the calls of any bats that fly within approximately 20 yards of your location. However, for the calls to actually be recorded we need to turn the recording feature of the detector on. To do this, tap the left most button at the bottom of the screen with the red circle. When the detector is in recording mode you will see a small green circle glowing at the top of the screen, and the red circle in the recording button should light up.
6. When in recording mode the unit doesn't actually record continuously, but rather it searches for ultrasonic sounds in the frequency range that are similar to bat calls. When it picks up such a noise, hopefully a bat call, it will start recording an audio file for as long as the noise persists. That file will be saved, along with the date, time, and location, and stored in a file folder on the iPad. It will do this automatically with no work on your part.
7. ****Important:** on the Live Mode screen, on the right hand side, there is a small orange arrow that can be slid up and down along the frequency scale. This sets the minimum frequency that will trigger the detector will start a recording. We want this to be pulled to near the bottom of the scale, in the 10-15 kHz range, to ensure that any bats that are encountered are also recorded. If the minimum value is set too high, bat calls will still be displayed on the screen in real time, but it will not save the audio file and other information.
8. When you encounter a bat, and if the detector spectrogram and iPad speakers are set correctly, you should start to hear chirps from the detector and begin to see vertical streaks of green or orange on the detector screen. You should also notice a white line that appears on the top of the screen; this indicates that a recording has

begun. As the bat gets closer, the chirps will get louder, and the colors on the spectrogram more vibrant. Once the bat has passed, and if the bat was close enough and enough individual calls were recorded, the detector will finish recording and display its best guess as to which species of bat you just observed. At this point, you've just recorded a bat and have collected data that will contribute to a statewide database of bat distributions in Maine!

Noise considerations: The detector will pick up only sounds that are in the ultra-sonic range, so most things that we can hear, like voices, music, and most bird songs, will go unnoticed and unrecorded. Some more subtle sounds will be picked up however, like the rustling of clothes, the sound of footsteps in grass, certain mechanical noises, and some insects. Random background noise is not necessarily a problem, but it does have the potential to obscure a bat call and keep it from being recorded. The detector will interpret noises in the same frequency range as bats as though they are bat calls. These noises can be clearly distinguished after the fact, but they take up space on the detector. So, while talking or quietly walking during a survey is perfectly fine, you'll want to be conscious of the noise the detector is picking up and try to minimize it as much as possible.

Accessing and viewing your recordings:

To review the calls of bats that you've recorded you'll need to exit live mode, at which point the detector will cease recording any new calls. For this reason we ask that you wait to look at the calls you've collected until after you've completed your survey for a night. At the main options screen, tap the "Recordings" tab to enter all of the stored recording on the detector. Each call will be recorded here with a file name that indicates the most likely species, date, and a time stamp. The species are recorded based on a four character "alpha code", which is commonly used as shorthand by bat biologists and corresponds to the Latin scientific name for each particular species. For example, little brown bats have the Latin name *Myotis lucifugus* and their alpha code is MYLU. The following table contains the alpha codes for all bats likely to be found in Maine:

Code	Common Name	Latin Name
EPFU	Big Brown Bat	<i>Eptesicus fuscus</i>
LANO	Silver-haired Bat	<i>Lasionycteris noctivagans</i>
LABO	Eastern Red Bat	<i>Lasiurus borealis</i>
LACI	Hoary Bat	<i>Lasiurus cinereus</i>
MYLE	Small-footed Bat	<i>Myotis leibii</i>
MYLU	Little Brown Bat	<i>Myotis lucifugus</i>
MYSE	Northern Long-eared Bat	<i>Myotis septentrionalis</i>
PESU	Tricolored Bat	<i>Perimyotis subflavus</i>

If you can't remember which is which, you can open the file by tapping the file name to view the spectrogram. Tapping the button in the lower right with the three vertical bars will condense the display so that you can see the entire series of calls. To view the species ID, tap on the small yellow bat icon next to the alpha code, approximately 2/3 of the way up the screen. This will open the bat ID window, which will list both the common name and Latin name for the species. You will also notice a small "learn more" option on the bottom of this window. If you tap that option, you will be directed to the Bat Conservation International species account for that particular bat species, which will contain information on their general biology, distribution, natural history, and conservation status, as well as photos.

Also from this screen, you can tap on the blue compass icon (next to the yellow bat) which will bring up a map screen that shows your location when each particular call was recorded. If you zoom out by "pinching" the screen, you can view all calls recorded and stored on your particular device. An icon in the upper left corner of the screen will allow you to toggle between a map view and a satellite image. However to access the BCI species accounts or the map data you will need to have a wireless connection.

Troubleshooting:

The app screen freezes: If the detector screen freezes while in Live Mode, and the app is not responsive, first attempt to close the app using the "Home" button on the iPad, and then re-open it. If the app then says you must connect the microphone (even though it is connected), removed the microphone and re-insert it. You will then need to follow the start-up steps to begin recording again. If the app is completely unresponsive (the home button will not work) you can remove the microphone, which should reset the app.

Calls not being recorded: If you are getting bat calls on the detector screen, but they are not being ID'd and the recorded files are not being saved, first check to make sure recording mode is turned on. Second, check that the orange slider on the left side that triggers recordings is below 15 kHz.

The detector is making sounds but nothing is on the screen: Tap the right-most button with the three vertical bars to allow the visual display to pan.

Caring for the acoustic microphone and iPad.

We appreciate very much your participation in this project, and we want you to use the detector confidently and put it through its paces without being too fearful of damaging the equipment. We won't hold you responsible if the equipment is damaged during normal use, but there are a few steps you can take to minimize the chances of damaging equipment in the field.

1. Every iPad has been outfitted with a protective case; please do not remove the iPad from the case.

2. The lightning connection between the microphone and iPad is pretty secure, but please be careful during use to avoid putting any pressure on the microphone that could cause the connection to bend or break.
3. When not in use, please store the microphone in its zippered pouch, and all equipment in the provided case.
4. You should avoid conducting surveys in poor weather (i.e. rain) because detecting bats is far less likely. Additionally, too much moisture could damage the detector's electronics, so please avoid getting the detector wet (the iPad cases are not waterproof). This should go without saying, but please also avoid dropping the detector in rivers, lakes, puddles, etc.

Other considerations for use:

1. Be sure to charge the iPad fully in between uses.
2. We have added some additional apps (flashlight, first aid, etc) to the iPad that might be useful to you in the field, and have disabled the ability to add additional apps to the unit. Having too many apps reduces the iPad's memory and may slow performance and impede our ability to record calls.
3. If you need to adjust the screen brightness, or connect to a wireless network, you can do so using the Settings app. Please do not otherwise tamper with the iPad's settings, add additional apps, or otherwise use the iPad in an inappropriate way.
4. We have set up each detector with the correct settings for normal use. Please do not alter settings within the Echo Meter app.

Data Form - Please fill out one form for each nightly survey that you conduct.

Name(s) of Observers: _____

Date of Survey: _____ Time Survey Began: _____ am/pm

Town and County of Survey: _____

Please describe the general location of your survey (e.g. street address or park name):

Please provide a general description of the habitat was present at the survey location (e.g. Forest, wetland, residential area, city park, open field, etc).

Were Bats Detected? (yes/no) _____

Did you see any bats during the survey (yes/no) _____

Was your survey Active (i.e. walking) or Passive (i.e. stationary)? _____

Time survey ended _____

Was the detector inactive for any amount of time during the survey? _____

How long do you estimate it was inactive, and what was the reason?

Other Comments or Observations?

Questionnaire – Please provide your feedback to the following questions on this or another sheet of paper.

1. Did you experience any trouble using either the app or the microphone during your surveys? If yes, please describe.
2. Did you find that the instructions we provided were sufficient to understand the detector and its operation? If no, do you have suggestions for how the instructions could be improved?
3. Did you use the detector for more than 30 minutes during a single survey?
Would you be willing to conduct surveys for >30 minutes, and if so, how long do you feel you would be willing to collect data on a single night?
4. How far did you travel from your home (if at all) when conducting the surveys?
How far do you think you would be willing to travel?
5. If only the acoustic microphone were available, would you be willing and able to provide your own iPad or iPhone to conduct bat surveys?
6. Do you have any suggestions for ways in which these detectors could be used as part of a successful volunteer-based bat monitoring program?

Appendix 2 - BatME Data Collection Protocols (Year 2)

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Overview: Bats are critically important but poorly understood species in many ecosystems, and recent declines in bat populations throughout the Northeast have generated concern over bat conservation. Bats may provide literally billions of dollars of ecological services in the form of insect pest control. White-nose bat syndrome (WNS), a fungal pathogen affecting cave-hibernating bats, was first identified in New York in 2006, and has spread rapidly throughout the Northeast, reaching Oxford County Maine in 2011. WNS has resulted in unprecedented declines in populations of cave-hibernating bats, with some species experiencing a 90% population decline over the last five years. In addition, mortality from wind turbines has been a concern, especially for migratory tree bats. The northern Long-eared bat is now a federally threatened species, and is listed as a Maine endangered species along with the little brown bat. The eastern small-footed bat is on Maine's threatened species list. There is now considerable interest in better understanding the distribution and abundance of bats in Maine and elsewhere.

Bats emit high-frequency calls for echolocation while flying and feeding. These calls are ultrasonic and are generally not audible to human ears, but they can be recorded using specialized acoustic equipment. Importantly, echolocation calls are also used to distinguish among different species of bats. Researchers from the University of Maine Department of Wildlife, Fisheries, and Conservation Biology, in collaboration with the Maine Department of Inland Fisheries and Wildlife and Maine Audubon, started a project in 2015 to explore the use of handheld bat acoustic detectors as tools for citizen scientists to collect data on bat distributions in Maine. Detector units consist of an ultrasonic microphone (smaller than a deck of cards) attached to an Apple iPad mini. The microphone interfaces with an "App" on the tablet that interprets and displays bat calls as they are detected.

Volunteers helped to test detectors and provide feedback on their use during the pilot field season, and we have used that information to refine our field protocols and data collection approach for 2016. Importantly this year we have incorporated a repeated sampling technique, which will allow us to better-account for the ability to detect bat species during a survey.

This work is supported by a grant from the [Maine Outdoor Heritage Fund](#) and the Maine Department of Inland Fisheries and Wildlife.

Volunteer Commitment:

BatME Survey Volunteers are asked to:

- Attend a two-hour workshop at one of our detector hubs, located at The University of Maine in Orono or the Gilsland Farm Audubon Center in Falmouth.
- Sign up for a 1-week BatMe survey period, which will require pick up and drop off of the detector at a detector hub.
- Conduct at least 2 surveys of the same location on different nights, each requiring at least 45 minutes of survey time beginning just after sunset.
- Complete survey data sheets and enter your data using our online form.
- Return detectors within 1 week of pickup.

Conducting bat surveys:

Once you've checked out a detector, we ask that you conduct at least 2 surveys that are repeated at the same location on different evenings during your 1-week check out period. This approach of repeatedly surveying a site is important because it will allow us to evaluate how well the surveys are able to detect different species of bats – when a species is detected during one nightly survey but not on the second, that implies that we have only about a 50% detection rate. We can use this information, along with some sophisticated data analysis, to generate more accurate estimates of statewide bat distributions.

During the week that you have the detector, we welcome you to survey more than 1 location, but please make every effort to conduct at least 2 nightly surveys at each location you choose. **If you don't hear any bats during one night that is still important data, and its also important to revisit that site and resist the urge to try somewhere else on the second night.** Information on the places where there are no bats is just as important to us as information on where bats are found. Also, feel free to conduct more than 2 surveys at a single site (e.g. 3 or 4 nights in a row).

Bats begin their nightly activity during the twilight period just after sunset. While you are welcome to conduct surveys at any time of night, we suggest that you begin recording approximately 15 minutes after sunset and continue recording for at least 45 minutes. You are welcome to continue recording for longer amounts of time, but 45 minutes should be your targeted minimum. Bats will be most active on calm, clear evenings, and you should conduct surveys on nights when there is no rain and when the wind is less than 10-15 mph (a light breeze or less).

Surveys may be active (walking) or passive (standing still), and the difference between these two types are described below.

Choosing a Survey Location

Our objective for this season is to sample bats in as many Maine towns as possible, and when you sign up to check out a detector we'll ask you to choose a specific town to survey. The specific location of your survey site is up to you as long as it stays within the boundaries of the town you've been assigned. We are interested in recording all species of bats wherever they occur, so the particulars of the location you choose to survey are not terribly important. A good starting point is those areas where you've noticed bats flying around in the evenings, like along your street, at a local park or natural area, or even in your back yard. Many species are attracted to open areas, like yards, fields, or meadows, and because bats eat insects, "buggy" places like wetlands, ponds, or along streams and rivers can be particularly productive. These are all great places to search.

Stationary vs. Active Surveys

After you've selected a location and started your survey, you should decide whether you want to survey actively, by moving around to different locations, or passively by staying put for the entire 45+ minutes while you are out. Both options have advantages and disadvantages. In an active survey, you will cover more ground and potentially encounter more bats in different places. This might make sense if you are surveying trails through a park, or walking through your neighborhood. The disadvantage is that the act of walking will create noise (see below) that the detector may pick up and that may mask bat calls. For active surveys, the best approach is to walk slowly and stop periodically in likely looking places and wait for 2-3 minutes to see if you record activity. If you happen to see a bat flying at twilight, trying to approach it in order to get calls is a great option, too. Walking along hard surfaces, such as pavement or gravel, produces less ultrasonic noise than walking through grass or other vegetation. If the detector picks up a bat while walking (you will know this because the detector will make sounds and display the calls; see description below), immediately stop and stand still while the call is being recorded.

Passive surveys may be more practical if you are surveying your backyard or at a point along a lake shore. You will cover less area, but will also survey a particular point more thoroughly and will introduce less noise to the detector. Sitting in a lawn chair sipping a beverage while the detector records passing bats is also perfectly acceptable approach to collecting bat calls. Please record on the data sheet whether you took an active vs passive approach to your survey.

Before You Start

For each location you survey, please fill out one of our repeated sampling data forms (attached to the end of this document). Here you will record important information such as your name, the town you are surveying, the dates and times of each repeated nightly survey, etc. This data is critically important to the project because it is what we will use to link the calls you record with the site that you have surveyed.

The data sheet will ask you for a number of pieces of information that you can obtain from the iPad, like start time and end time, as well as some information on your location that can be obtained from the “HandyGPSFree” app, which you will find on the iPad. Tap the app to open it, and from the first screen that opens record the Easting and Northing values on your data sheet. Also, check the odometer reading to see that it is at a value of 0 m, and hit the reset button if it is not.

When you've finished your survey for the evening, record your ending time, and open the GPS app again. Record the odometer reading for your survey (this is the total distance you traveled while surveying) and reset the odometer. If your survey was passive, the odometer should be close to 0 m.

Use the same datasheet for each repeated survey that you conduct at the same site. If you survey more than 1 site while you've got the detector, fill out a new survey form for each additional site. Remember that we would like you to survey a particular site, starting from the same location, at least two times (more than two is also good).

After you finish

You can help us out by entering your datasheets using our online Google Form located at batme.org/data-entry (notice that the BatME web page can be accessed from a linked shortcut on the iPad when connected to wireless). You will be asked to provide a password, which is *batdata* (all lower case), and then should be able to access a quick online form with the same options as the sheet you completed in the field. Hit “submit”, and your data will be entered. If you cannot complete the data entry, please let us know when you return the detector, and also turn in your hard copy forms either way.

Using the handheld detector:

The detector unit consists of a Wildlife Acoustics Echo Meter Touch microphone connected to an Apple iPad mini2 by a short extension cable. The microphone picks up the ultrasonic calls of bats, which are generally in a much higher frequency than a standard microphone (or the human ear) can detect. Calls are interpreted by the Echo Meter app on the iPad, which takes advantage of the iPad's computing power to record and analyze the incoming bat calls and display them in a way that we can interpret. The app displays the bat calls as a colorful spectrogram (a graphical depiction of a sound) and translates the ultrasonic calls into a near-sonic sound that our ears can detect, which will sound similar to a chirping bird. Once a series of calls has finished, and if the call was of sufficient quality, the detector will also produce an "AutoID" estimate of what bat species was making the call (but see our caveat about the AutoID accuracy below). The detector will record the sound file, and will georeference the call's location using the iPad's GPS.

When beginning a survey, please follow these steps:

Set Up:

9. Plug the EchoMeter Touch microphone into the lightning port of the iPad using the extension cable. The iPad should pop up a small window asking if you would like to access the Echo Meter app. Click yes. If this doesn't happen, try unplugging the cable and rotating in 180 degrees before plugging back in.
10. The opening screen asks if you would like to start live mode. Press the large green button to do so. This activates the recording screen.
11. Once live mode has started, you should see a scrolling screen with changing colors as the screen scrolls. If the screen is not in motion, tap the small button with three vertical lines at the bottom of the screen; this will change the speed at which sounds are displayed to real time.
12. You also should hear some sort of static-like noise in the background. If not, check the second button from the left at the bottom of the screen. If it reads "off" tap it once and you should hear static. If you still do not hear anything, check to make sure the iPad speakers are turned on and that the volume is up.

Recording Calls:

13. Once the detector is in live mode, it will pick up and display the calls of any bats that fly within approximately 20 yards of your location. **At the bottom of the screen on the left side you will see two nested round buttons, one with a red circle and a smaller sub-button with an "M" in the center. Tap the larger (right) button to start recording calls.** When the detector is in recording mode you will see a small green circle glowing at the top of the screen, and the red circle in the recording button will light up.
14. When in recording mode the unit doesn't actually record continuously, but searches for ultrasonic sounds in the frequency range similar to bat calls. When it picks up such a noise, hopefully a bat call, it will start recording an audio file for as long as the noise persists. That file will be saved, along with the date, time, and location, and stored in a file folder on the iPad. It will do this automatically with no work on your part.
15. ****Important:** on the Live Mode screen, on the right hand side, there is a small orange arrow that slides up and down along the frequency scale. This sets the minimum frequency triggering the detector to start recording. We want this to be pulled to near the bottom of the scale, in the 10-15 kHz range, to ensure that any bats that are encountered are recorded. If the minimum value is set too high, bat calls will still be displayed on the screen in real time, but will not be saved as audio files
16. When you encounter a bat, and if the detector spectrogram and iPad speakers are set correctly, you should start to hear chirps from the detector and begin to see vertical streaks of green or orange on the detector screen. As the bat gets closer,

the chirps will get louder, and the colors on the spectrogram more vibrant. Once the bat has passed, and if the bat was close enough and enough individual calls were recorded, the detector will finish recording and display its two best guesses as to which species of bat you just observed. The species listed first is the more likely of the two. At this point, you've just recorded a bat and have collected data that will contribute to a statewide database of bat distributions in Maine!

Noise considerations: The detector will pick up only sounds that are in the ultra-sonic range, so most things that we can hear, like voices, music, and most bird songs, will go unnoticed and unrecorded. Some more subtle sounds will be picked up however, like the rustling of clothes, the sound of footsteps in grass, certain mechanical noises, and some insects. Random background noise is not necessarily a problem, but it does have the potential to obscure a bat call and keep it from being recorded. The detector will interpret noises in the same frequency range as bats as though they are bat calls. These noises can be clearly distinguished after the fact, but they take up space on the detector. So, while talking or quietly walking during a survey is perfectly fine, you'll want to be conscious of the noise the detector is picking up and try to minimize it as much as possible.

Accessing and viewing your recordings:

To review the calls of bats you've recorded you'll need to exit live mode, at which point the detector will cease recording any new calls. For this reason we ask that you wait to look at the calls you've collected until after you've completed your survey for a night. At the main options screen within the app, tap the "Recordings" tab to view all of the stored recordings on the detector. Each call will be recorded with a file name that indicates the most likely species, date, and a time stamp. The species are recorded based on a four character "alpha code", which is commonly used as shorthand by bat biologists and corresponds to the Latin scientific name for each particular species. For example, little brown bats have the Latin name *Myotis lucifugus* and their alpha code is MYLU. The following table contains the alpha codes for all bats likely to be found in Maine:

Code	Common Name	Latin Name
EPFU	Big Brown Bat	<i>Eptesicus fuscus</i>
LANO	Silver-haired Bat	<i>Lasionycteris noctivagans</i>
LABO	Eastern Red Bat	<i>Lasiurus borealis</i>
LACI	Hoary Bat	<i>Lasiurus cinereus</i>
MYLE	Small-footed Bat	<i>Myotis leibii</i>
MYLU	Little Brown Bat	<i>Myotis lucifugus</i>
MYSE	Northern Long-eared Bat	<i>Myotis septentrionalis</i>
PESU	Tricolored Bat	<i>Perimyotis subflavus</i>

If you can't remember which is which, you can open the file by tapping the file name to view the spectrogram. Tapping the button in the lower right with the three vertical bars will condense the display so that you can see the entire series of calls. To view the species ID, tap on the small yellow bat icon next to the alpha code, approximately 2/3 of the way up the screen. This will open the bat ID window, which will list both the common name and Latin name for the species. If you tap the bat name, you will be re-directed to the Wikipedia page for that particular bat species, which will contain information on their general biology, distribution, natural history, and conservation status, as well as photos. This option will require a wifi connection.

Also from this screen, you can tap on the blue compass icon (next to the yellow bat) which will bring up a map screen that shows your location when each particular call was recorded. If you zoom out by "pinching" the screen, you can view all calls recorded and stored on your particular device. An icon in the upper left corner of the screen will allow you to toggle between a map view and a satellite image. This also requires a wifi connection.

Troubleshooting:

The app screen freezes: If the detector screen freezes while in Live Mode, try pressing the right-most bottom button with three vertical bars. Tapping it again should take you back to continuous recording. If the app does not respond, next try to close the app using the "Home" button on the iPad, and then re-open it. If the app then says you must connect the microphone (even though it is connected), remove the microphone and re-insert it. You will then need to follow the start-up steps to begin recording again. If the app is completely unresponsive (the home button will not work) you can remove the microphone, which should reset the app.

Calls not being recorded: If you are getting bat calls on the detector screen, but they are not being ID'd and the recorded files are not being saved, first check to make sure recording mode is turned on. Second, check that the orange slider on the left side that triggers recordings is below 15 kHz.

The detector is making sounds but nothing is on the screen: Tap the right-most button with the three vertical bars to allow the visual display to pan at real-time.

The screen is working but there are no sounds: First, check the second button from the left at the bottom of the screen. If it reads "off" tap it once and you should hear static. If you still do not hear anything, check to make sure the iPad speakers are turned on and that the volume is up.

iPad completely freezes. First, try tapping the "home" button. If this doesn't work, power down the iPad, wait one or two minutes, and re-start.

Caring for the acoustic microphone and iPad.

We want you to use the detector confidently and collect data without worrying about damage. But with that said each unit is worth approximately \$900, and we also want to ensure that they are taken care of and adequately maintained. We will ask you to complete a check out form and provide us with your drivers license number when checking out the unit.

Here are some additional steps you can take to minimize the chances of damaging equipment in the field.

1. Every iPad has a protective rubberized case; please do not remove the iPad from the case.
2. The lightning connections between the microphone, cable, and iPad are fairly secure, but avoid putting any undue pressure on the microphone that could break or bend the connection.
3. When not in use, store the microphone in its pouch and all equipment in the provided storage case.
4. Do not conduct surveys in poor weather (i.e. rain) because detecting bats is far less likely and too much moisture may damage the detector's electronics. Keep water off the detector because the iPad cases are not waterproof. This should go without saying, but do not drop the detector in rivers, lakes, puddles, etc.

Other considerations for use:

1. Charge the iPad fully between uses.
2. There are additional apps (first aid, etc) on the iPad that might be useful in the field. You may not add additional apps to the unit. .
3. If you need to adjust the screen brightness, or connect to a wireless network, you can do so using the Settings app. Please do not otherwise tamper with the iPad's settings. The iPads are to be used for BatME surveys only and not for any other personal uses.
4. We have set up each detector with the correct settings for normal use. Please do not alter settings within the Echo Meter app.

BatME Tablet-based Survey Data Form - Please fill out one form for each night that you conduct a survey at a specific location. If you survey additional locations, please complete a new form. You can help us by entering your data at batme.org/data-entry Password = batdata. You will also find a link to the data entry site on the home screen of the iPad and can use it to enter data if you like.

Name(s) of Observers: _____ Detector ID:

Town of Survey: _____ Easting _____ Northing

Night No.	Date	Start Time	End Time	Active/Passive	Distance
1					
2					
3					
4					
5					

* Easting and Northing values (GPS location) and Distance can be obtained from the HandyGPS app on each iPad. Instructions for completing this data sheet may be found beginning on page 3 of the BatME protocols.

Other Comments or Observations?

Appendix 3 – BatME Data Downloading Protocols

Below you will find a series of protocols and step-by-step instructions for data downloading and storage for the BatME project. Depending on which aspects of the project you are helping us with, some or all of these procedures may apply to you. If you have any questions, please contact Erik or Sabrina.

File Naming and Sharing: We have setup an online Google Drive folder and granted access to everyone involved in data downloading. Depending on whether you have a Google account or not, the process for accessing the Drive folder may differ. The instructions below assume that you have already accessed Google Drive. If you need help troubleshooting how to do that for the first (or second, or third) time, please contact Erik or Sabrina individually.

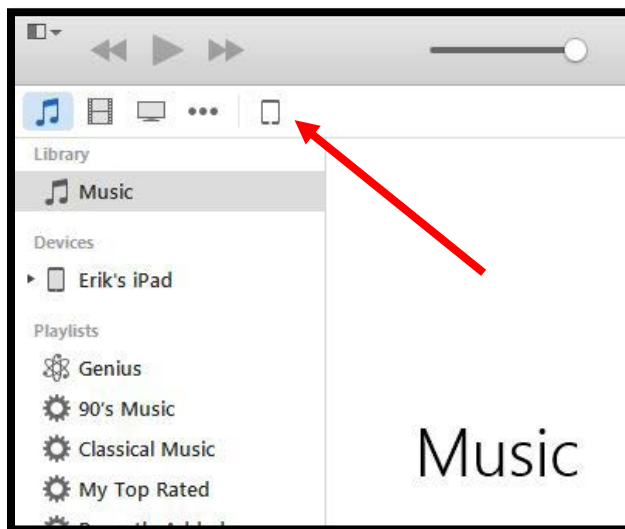
Within Google Drive, you will find subdirectories for Tablet Data (i.e. data obtained from iPads), Stationary Data (data from stationary detectors), and Driving Transects (data from vehicle-based surveys). Data from each individual tablet or stationary detector should be saved in a single folder within these subdirectories, and we will add data to each folder as the season progresses. We recommend using Google Chrome for managing file downloads as it seems to work the most seamlessly with Google Drive.

For file transfer into Google Drive, you will need to first download data from the iPad's or memory cards onto your computer, and then transfer them into Drive. We recommend adding a folder to your desktop titled "BatME Downloads" or something similar. Within that folder, you may wish to create subfolders for each BatME detector you are using so that you can keep the files organized as you transfer them between their source and onto Google Drive. Once you've transferred files to Drive, you can delete them from your computer to save space, so as an alternative to individual folders you could also just remove all of the files once they have been transferred for one detector before beginning another download. The very important step here is to keep very careful track of the files from each individual detector.

Below we will describe the process for downloading files from the detector, and then will follow with the process for uploading them to Drive.

Downloading data from iPads: The easiest method for retrieving EchoMeter bat recordings from the iPad is using Apple iTunes, which is available for free download (<http://www.apple.com/itunes/download/>) and can be loaded onto any computer regardless of operating system. The following is a list of step-by-step instructions for data download from the iPads – this process will be the same regardless of which project component (volunteer repeated surveys, driving surveys, colony counts, etc) data were collected for.

1. Plug the iPad into a USB connection on your computer. You will most likely see a pop-up message on the iPad asking if you trust this computer, press yes to this and any other messages you see on the iPad.
2. iTunes will probably open automatically, but open it if it does not. The software will ask if you want to access information on the iPad – click continue.
3. In the top left corner of iTunes, click on the small iPad icon. This may take a moment or two to show up as your computer connects with the tablet:



4. Click on the “Apps” button on the left side of the screen, and then scroll down. At the bottom of the page you should see an icon for the Echo Meter App. When you click on the app, a series of file folders should appear to the right.
5. Use the shift key to click on and highlight all folders. Then click the “save to” button in the lower left.
6. Choose the file folder that you created on your desktop or elsewhere, and click “Select Folder”. On the top of the screen in the center you should see a status update from iTunes that will say “Copying Files from ...” with the current status. For large downloads this may take a minute or two, and for just a few nightly sessions it may crank through in just a few seconds. When the Apple icon returns to the top center of the status bar, your download is finished.
7. Once the download is completed, open Windows Explorer and check the download file folder to see that the files transferred.

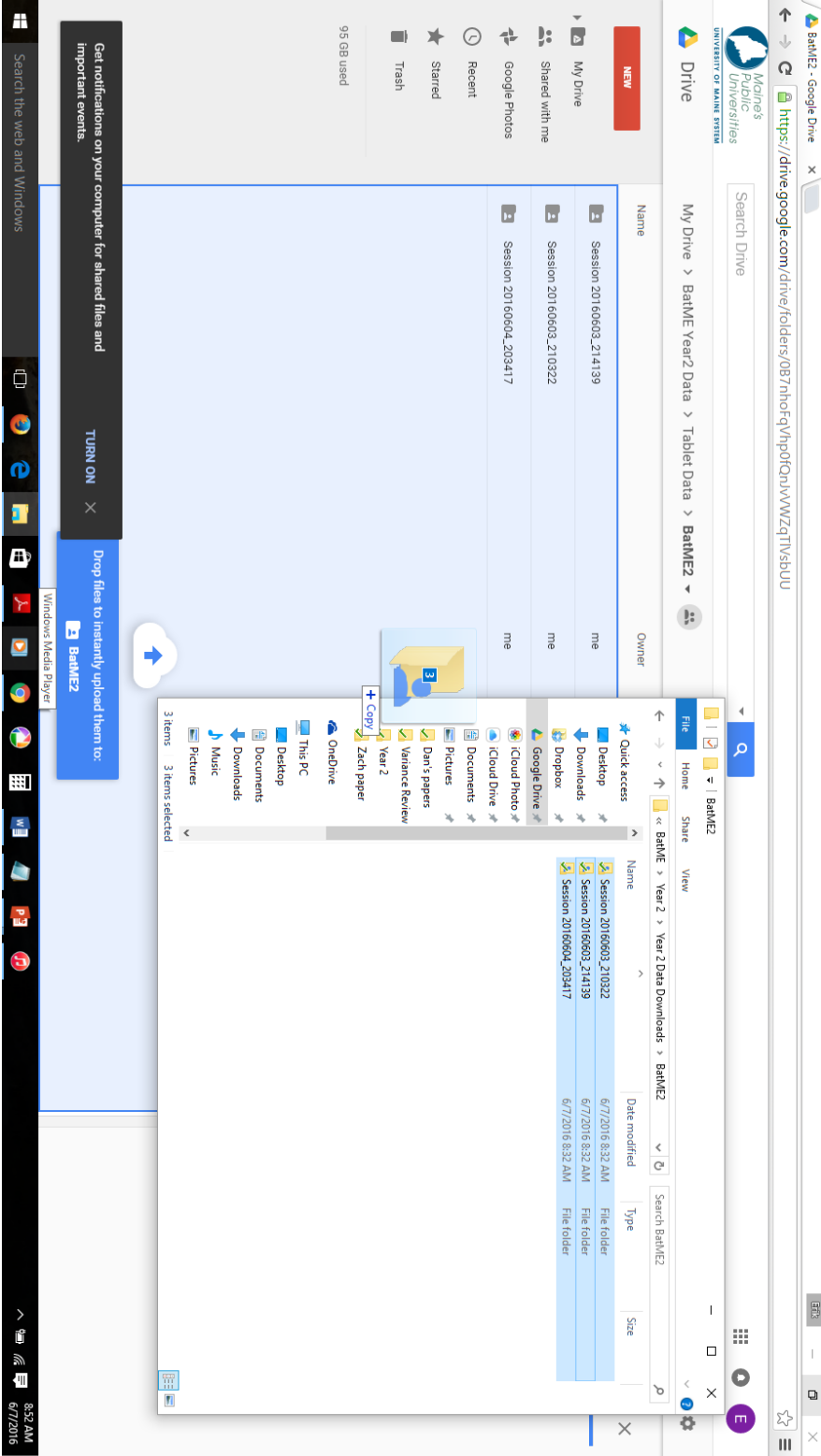
Transferring files to Google Drive:

1. Once you have your files downloaded, access the Google Drive Folder using Google Chrome. Navigate to and open the sub-folder for the detector you are downloading data for.
2. With Drive open and it's window maximized, open Windows Explorer and navigate to the folder containing the data from your detector. Click on and highlight all of the nightly sub-directory folders you wish to copy. Once they are all highlighted, you can drag the files into Google Drive to initiate the data uploading process. See the screen shot on the last page of these instructions for a visual example.
3. Once the files are successfully uploaded onto Google Drive, they can be deleted from both your computer's hard drive and the iPad.
4. ***Important – Please do not delete any files from Drive for any reason. If you believe that you have incorrectly uploaded a file (e.g. duplicated the file or put it in the wrong place) contact Erik or Sabrina for assistance.***

Downloading and uploading data from stationary detectors: In general the process for transferring data from a stationary detector will be similar to that of the iPads, except for the few differences described below.

1. Most modern stationary detectors will use an SD memory card and files can be transferred from them directly onto your computer without any special software (e.g. iTunes). Insert the card into a card reader (many laptops have a dedicated port for SD cards), open Windows Explorer, and find the card. You should see two things present on the card – a folder labeled “Data” and a text document labeled SM3XXXXX_Summary. We want both of those two items transferred.
2. In Google Drive, access the folder labeled “Stationary Data”. Within this folder, there should be subfolders for each individual stationary detector that we are using this season. Your detector should have a label indicating its individual ID; Stationary1, Stationary2, etc. Open the folder specific to that detector.
3. Within the detector subdirectory, create a new folder and name it for the unique site ID for the location you surveyed. To do this, click on the “New” button in the upper left corner, and select “Folder”. Name the folder using the site ID you created for that particular site (e.g. “EJB1”). Click Create.
4. Once the folder is created, you can drop and drag the Data Folder and Summary file directly from the memory card (accessed using Windows Explorer) into the site-specific folder on Drive. See step 2 in the previous section for a reminder of how to do this.
5. After data has been transferred and you've confirmed the transfer was successful, you can delete the files from the memory card. The best way to do this is to format the card using menu options on the stationary detector itself, which will ensure proper file formatting. Erik or Cory will show you how to do this when they provide you with the detector.

Example screenshot for drag and drop transfer of files using Google Drive and Windows Explorer.



Appendix 4 – BatME Paired Survey Protocols

Overview: As part of our continued effort to refine and evaluate the BatME Project's ability to collect high-quality, useful data on bat distributions in Maine, we are initiating a series of "paired" surveys where we will compare data collected using stationary acoustic detectors (i.e. those traditionally used to collect bat acoustic data) with data collected at the same locations with the tablet detectors and BatME survey protocols. This will allow us to assess the degree to which nightly surveys conducted by BatME volunteers collect data that provides similar information to a stationary detector placed in the same location for a longer amount of time. Based on the results, BatME protocols can be further refined to improve our data collection. Thanks for your help with this very important component of our 2016 field season.

Protocol for stationary surveys: Stationary detectors (e.g. Wildlife Acoustics SM4Bat) should be set for one week with a target of 6 consecutive survey nights before moving to a new location. For these surveys we will only use full-spectrum acoustic detectors with omni-directional microphones. Detectors should begin recording at sunset and to turn off at sunrise, and detector date/time stamps should be checked for accuracy. In general if we have provided you with a detector you can assume that it is set correctly, but please consult with Cory Mosby or Erik Blomberg if you have any questions.

Detector placement:

- Detectors should be set in locations where the probability of detecting at least some bats is likely – e.g. clearings, stream corridors, woods roads, etc – and where paired tablet-based surveys are also practical.
- Microphones should be placed approximately 1 meter off the ground with the microphone oriented in a downward 45 degree angle.
- Detectors should be moved to a new location after 1 week (6 nights) of deployment. It is alright to deviate from the 6-night guideline if necessary, but try to keep survey lengths within 5-7 nights if possible.
- When moving the detector please select a new location at least 1 mile from the previous location.

Site naming convention

- All sites will need a unique ID that can be used to link data collected by stationary detectors to data collected by tablet-based surveys.
- We will use a combination of observer initials and site order to name each site. For example, if Jane Julia Smith conducted surveys at a first site, that site would be named JJS1. If she surveyed a second site, that location would be JJS2, and so on.

- This naming convention will allow us to maintain unique identifiers for each site among different observers.
- Being consistent in the naming convention of the site ID, particularly among repeated surveys at the same location, is very important for data analysis purposes.

Protocol for tablet based surveys: Nightly surveys using tablet-based detectors should follow the general protocols for conducting a BatME Survey. You may refer to the complete protocols, but here we will provide a brief summary of those methods.

- Conduct tablet surveys at the location of the stationary detector, at least twice during the same 1-week period that the stationary detector is deployed.
- Surveys should begin 15 minutes after sunset and last for at least 45 minutes. Feel free to exceed these minimum guidelines, but do not feel obligated to.
- As you survey additional sites (i.e. move the stationary detector) please alternate between “active” or “passive” tablet surveys. For an active survey, walk with the tablet in the general area surrounding the stationary detector, allowing the EMT to pick up bats as you go. The pattern you choose to use while walking can be haphazard and driven by site-specific characteristics (e.g. locations of trails or roads) but please do not exceed a 1/4 mile distance from the detector location and whenever possible keep the stationary detector approximately centered in the area you survey.
- For passive surveys, remain in the same general area (e.g. within 50 m) of the stationary detector. You may leave the tablet running unsupervised, but its best if you can check on it periodically to make sure the app hasn’t frozen. When leaving the detector to run by itself, it’s best to turn off the iPad display while the app runs in the background.
- In general we hope to conduct approximately an equal number of active and passive surveys. During our 2015 pilot season, volunteers reported an even mix of these approaches, and we suspect that pattern will continue as the program expands. In choosing among either survey type, feel free to consider site-specific attributes. For example, a stationary detector placed at a camp or backyard may lend itself to a passive survey, whereas one placed in an area with walking trails would be more conducive to an active survey.

Data Forms and Entry: Please complete one “Stationary Detector Form” for each site that you survey, and one “Tablet-Based Survey Form” for each nightly tablet survey that you conduct.

You can help us out by also entering your data online through our Google forms. The form for stationary detectors can be found at <http://goo.gl/forms/W8EhJ7niWD>, and the form for tablet surveys can be found at <http://goo.gl/forms/wVUy3JQLG9>