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## PROJECT TITLE

Distribution, Assemblage, and Activity of Bat Species in a Temperate Urban Landscape❖
❖ *Proposed for renewal of previous grant*

## INVESTIGATORS

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*Note: This proposal represents an extension of the bat acoustic survey study conducted in 2008 at Black Rock Forest and other green spaces in the New York metropolitan area. A renewal of the 2008 grant for the 2009 project season is requested.*

## PROJECT DESCRIPTION

Background

Effective bat conservation requires a thorough understanding of bat populations, including an assessment of population trends, species diversity, and species distributions. Addressing this matter is particularly urgent given an emerging major threat to the persistence of bat populations in the northeastern United States: the significantly high mortality rate of wintering bat colonies since 2006 credited to the spread of *white-nose syndrome* (WNS), a condition named for the most obvious observation of white fungal patches on the muzzles and bodies of infected bats, though, it is unclear if the cold-loving soil fungus[1] is the causative agent responsible for the die-off or is an effect of some other illness. Initially centralized around Albany, New York, it is unknown how far south the epidemic has reached in New York State; however, WNS has been detected in Morris County, New Jersey,[2] and current population trends strongly suggest that bats in the New York City area may originate from or be affected by nearby afflicted populations next year, if they are not already compromised.[3] In light of this, there is an urgent need to monitor the progression and impact of the epidemic among bats in New York with a focus on southern localities, particularly among urban sites that serve as refugia supporting bat populations yet receive less attention than more rural environments (Carl Herzog, *pers. comm.*).

Considering the threat of a collapse of bat populations in the northeastern U.S. due to the fungus-related syndrome, which could have far-reaching ecosystem consequences, a basic assessment of the diversity, distribution and composition of bat species in the New York metropolitan region is essential for making informed decisions related to the management of bats and parklands in this area. In 2008, the authors conducted a non-invasive acoustic survey of insectivorous bats at Black Rock Forest using time-expansion detectors, which was made possible by the generous funding support from the Black Rock Forest Consortium. The implementation of the project was successful and resulted in the inception of the first systematic acoustic survey of vespertilionids in urban and suburban parklands in the New York metropolitan area (*see* the Appendix for summary report) thereby furthering our knowledge base about bat ecology in an increasingly urbanizing world. The proposed study aims to build upon the triumph of the 2008 survey in three ways: 1) by comparing two echolocation recording techniques to identify and select the best practice for urban bat surveys, 2) by expanding the radius to include additional sites for surveying bat populations along an urban-rural gradient, and 3) by investing in the establishment of a long-term echolocation monitoring program wherein Black Rock Forest, and other green spaces in the metropolitan area, are repeatedly surveyed in successive seasons to track changes in population and community trends over time.

Bats extract important information about their environment from the echoes of their ultrasonic calls and in many cases these pulse echolocation signals exhibit consistent species-specific characteristics.[4] With the appropriate equipment, mobile sampling of echolocation calls can reveal a variety of different aspects of bat ecology over large landscape scales. The advent of bat detectors capable of transforming ultrasonic calls into audible signals has led to the increased use of passive or active monitoring of echolocation calls produced by free-flying bats as a non-invasive practice for studying bat populations. Mobile, or active, sampling of bat calls can result in increased quality of detected calls and reveal a variety of different aspects of their ecology over larger spatial scales than with stationary call detection methods.[5] Various techniques have been used for acoustic surveys (e.g. frequency division, heterodyne, and time-expansion approaches), all of which have contrasting limitations[6]. Time expansion (TE) is the preferred detection technique, and is particularly suited for this project, because TE detectors perform well in a variety of flyways, are potentially more sensitive to ultrasonic acoustic signals than other detectors,[7] and recordings of calls from these detectors provide high-resolution full-spectrum acoustic signals that contain all of the diagnostic character data necessary for the effective identification and discrimination of bat species and/or group in the absence of a regional call library. Under the TE system implemented in this study using the Indicator Bats (iBats, www.ibats.org.uk) Program protocol, echolocation calls will be georeferenced so as to identify the location of the bat along the transect at the time the call was detected. The real-time detection system employed by the New York State Department of Environmental Conservation also provides accurate information regarding the harmonics of echolocation calls, but, unlike TE systems, allows for continuous detection and recording of calls and offers spectral viewing in real-time, though these added features lead to the production of very large sound files and greatly extends analysis time.

In light of this, the proposed study will compare the usefulness of both detection systems for collecting, recording and analyzing bat echolocation calls in an effort to examine bat species diversity, distribution, and activity in and around natural areas in New York City and the neighboring environs during the non-hibernating period of bats in this region (*see* Fig. 1). Acoustic signals recorded in 2009 from both systems will augment the dataset collected during the 2008 survey and will be used to: 1) complement recordings collected in 2008 to generate fundamental information on the dynamics of bats among habitats representing different levels of human disturbance (e.g. from heavily impacted to less impacted environments) in the New York metropolitan area, 2) characterize the extent to which bats use urban parkland, and 3) assess the importance of urban and semi-urban green spaces as foraging habitat for bats.

As part of the proposed research endeavor in the New York metropolitan area, selected parks will be surveyed for the presence of bats, echolocation calls will be recorded and assigned to species, species groups or species guilds, and call sequences will be used to characterize bat distributions and quantify bat activity in urban and rural areas during the non-hibernating period of northern temperate region chiropterans. It is expected that bat species with broad ecological requirements will be detected in the urban environments. In addition, it is expected that bat species diversity will be higher in rural or low-disturbance environments than in habitats in highly modified areas, and vice versa with respect to bat activity.

## Project Design

### *Study Sites*

In 2008, Black Rock Forest and four urban public parks managed by the New York City Department of Parks and Recreation (Central, Prospect, Forest, and Pelham Bay Parks) (Fig. 1) – all varying in their level of habitat modification, surrounding matrix of urban development, and proximity to the New York City urban core – were actively surveyed for the presence of bats by non-invasive detection of their echolocation calls using time-expansion detectors. Transects at these five sites will be re-surveyed in 2009. The project will also be expanded to include more locations. Access has been granted by local management agencies to conduct surveys at four additional sites in the New York metropolitan

area in 2009: the borough of Staten Island (New York City), Mianus River Gorge Preserve (Bedford, New York) and surrounding area, Sterling Forest State Park (Tuxedo, New York) and surrounding area, and Ringwood State Park (Ringwood, New Jersey) and surrounding area (Fig. 1).

*Sampling Protocol*

The sampling methodology will closely follow the protocol used for surveying bats in 2008. A mobile surveying approach using bat detectors will be implemented to conduct the surveys in the New York Metropolitan area using an adaptation of the Indicator Bats (iBats) monitoring protocol. Its implementation allows for the detection of the nine species of bat occurring in New York State. A single continuous near linear transect will be selected using existing public roads and will cover most of the habitat types present at each designated site; this will minimize backtracking and will aide in precluding detection of the same bat more than once. Bat echolocation transects in Central Park and Black Rock Forest will be surveyed once a month from May 2009 through October 2009 for spatiotemporal comparison. Prospect Park and Sterling Forest State Park will be surveyed twice – once in July and once in August (coinciding with peak bat activity) – during the same time period. These four transects will be used as part of a long-term monitoring program for the following years. In addition to the designated monitoring routes, each of the remaining parks will be surveyed once during the summer months (June – September) to generate distribution maps of local species. The mobile transect route will commence 30-45 minutes following sunset, which corresponds to an increase in bat activity in relation to an increase in insect activity and incorporates variance in bat emergence times.[8] Transects will be driven at a speed of ~ 16km/hr (10mi/hr; Black Rock Forest) or 19km/hr (12mi/hr; at other sites) for up to 40km (max. of 1.5 hrs) during the 6-month survey period and bat detection will be carried out from the vehicle. Typically, car noise will not interfere with detector performance and bat call signals can be filtered from the background noise (Jon Russ, *pers. comm.*). Environmental factors have been reported to influence directly or indirectly the flight activity of bats;[9] therefore, nightly weather conditions of ambient temperature, relative humidity, cloud cover, wind speed, and moon phase will be recorded. No surveys will be conducted during periods of inclement weather.

*Sound recording*

Two detection systems will be employed. Based on the iBats monitoring protocol, calls will be captured using time expansion (TE) bat detectors (Tranquility Transect, Courtpan Design, Ltd) mounted onto vehicles and recorded on to a minidisk player in 320 millisecond snapshot periods. GPS palm devices will also accompany the TE detector units so as to obtain georeferencing points on transects and for the recorded calls. Recognizing that the snapshot sampling methodology proposed in this study will not capture calls from all bat species in a given area – for example high aerial fliers or low intensity echolocators[10] – and that calls are being sampled intermittently, this protocol has the advantage of covering large tracks of the landscape at a particular site and allows for the general documentation of species distribution patterns that can be monitored over time. This study will also implement the acoustic survey methodology employed by the New York State Department of Environmental Conservation. In collaboration with Carl Herzog, wildlife biologist at the NYS DEC, echolocation calls will be collected at each designated site using the AR125 real-time recording ultrasonic detectors (Binary Acoustic Technology, Tucson, Arizona) mounted on the vehicle and recorded directly to a laptop computer via the SPECT'R software (Binary Acoustic Technology, Tucson, Arizona). This protocol allows for the continuous recording of echolocation calls, though large sound files and extra analysis time is expected.

*Data Analysis*

To determine efficacy of the iBats and NYSDEC echolocation call collection and recording protocols, measurable features of call signals of bats as recorded by the two detection systems will be compared. Audible time markers will be recorded to ensure that the characteristics for the same calls of the two systems will be analyzed. From each time marker, identification of the same signals will be

further verified using the timing of the call and the call features. Spectrogram analysis of acoustic signals from the TE detection system will be done using the BatSound v3.3 software (Pettersson Elektronik AB, Uppsala, Sweden). The SPECT'R v3.0 software will be used to analyze calls digitized to the laptop computer from the wide bandwidth detectors. For each complete search call sequence recorded in this study irrespective of the detection system, the initial and terminal frequency components of the call structure and the call duration will be measured. The characteristics assessed for each call sequence in this study will be used in conjunction with the overall shape of the sonogram (e.g., slope of the body) to compare the signal to a reference call library that contains calls of known species identity, taking into account slight differences in call structure due to intraspecific variation.[10, 11, 12, 13] Based on the comparison, the echolocation call will be assigned to a bat species, species group, or guild. A species, species group, or guild list will be generated for each study site. For calls collected using the iBats protocol, spatiotemporal associations of species along the surveyed transects will be evaluated using the generalized linear model (GLM) analysis method in the SPSS Advanced Models (v.13.0) statistical package (SPSS Inc., Chicago, IL.). Similarly, habitat-species relationships will also be assessed using GLM. Lastly, the number of bat passes recorded during each call collection snapshot period will be used to measure relative levels of bat activity within each site.

Expected outcomes and products

It is expected that the success of the 2008 and 2009 survey seasons will expand in subsequent years to supplement the currently proposed survey locations with more urban, suburban, and rural habitats and will become the launching point for a long-term bat monitoring program in this region. The survey results will be submitted for publications to selected peer-reviewed scientific journals, circulated within the American Museum of Natural History and the Center for Biodiversity and Conservation via in-house reports, and also made freely available to the general public and educators. A final report of the findings will be distributed to park managers and city and state officials responsible for the management of wildlife and natural spaces in the New York metropolitan area. In addition, outreach efforts, such as guided bat walks for members of the American Museum of Natural History, and volunteer activity will promote greater public awareness of bat ecology and exposure to urban biodiversity in the New York metropolitan area.

Research Timeline

| | |
|---|---|
| *April* 2009 | Acoustic monitoring training sessions for project volunteers. |
| *May – October 2009* | Acoustic surveys at nine project sites: *May through October* = Central Park and Black Rock Forest (one survey at each site each month); *July and August* = Prospect Park and Sterling Forest State Park (one survey at each site each month); *June* = one survey each at Mianus River Gorge Preserve and Staten Island greenway; *July* = one survey at Forest Park; *August* = one survey at Ringwood State Park; *September* = one survey at Pelham Bay Park. |
| *June and July 2009* | Conduct four public bat walks in Central Park (two walks each month). |
| *November 2009 – May 2010* | Data analysis and manuscript production; presentation of findings to partner organizations. |

Summary of Project Needs

Financial support to sustain the non-invasive acoustic survey for the 2009 season is crucial in order to test spatial and temporal patterns observed in 2008 and to ensure the initiation of a long-term monitoring program. We hereby request an extension of funding to support the acoustic survey study for the 2009 season. Categories for funding include transportation to, from, and within the Black Rock Forest, labor support, and recording supplies. The following budget table itemizes the overall project

expenses.

## BUDGET

The following budget table itemizes the project expenses for the non-invasive bat acoustic survey project to be executed in 2009. To support the success of the study, $2,978.80USD is requested from the Black Rock Forest Consortium. ** *Requesting funding or support*; † *In-kind support and resources confirmed.*

| Item | Description | Cost | NYCBG | CBC | NRG | NABCF** | BRF** |
|---|---|---|---|---|---|---|---|
| **Travel Expenses** | Vehicle rental for driving transects (1 rental vehicle; $132/day rental incl. tax & insurance; 6 separate rentals | $2,772.00 | | | † (For 3 NYC parks) | $ 1,056.00** | $ 792.00** |
| | Gas (federal government rate: $0.585/mi; 15 roundtrips; BRF= $0.485/mi for 180mi max) | $1,219.80 | | | † (For 3 NYC parks) | $421.00** | $523.80** |
| **Labor** | Postdoctoral Associate Stipend (10 days for BRF, Mianus, Sterling & Ringwood) | $2,150.00 (For all sites) | | † (For non-BRF sites) | | | $1,505.00** (For BRF) |
| | Volunteers (1 team of 3 surveyors/mo.; 6 mo. study; $125.00/team/mo.) | $750.00 | † | † | † | | |
| **Field Equipment** | Tranquility Transect time expansion bat detector, 1 detector plus necessary cables and clamps @ $885 (Alana Ecology) | $41.00 (Pro-rated; 10 year lifespan) | | † | | | |
| | Sony MZ-NH600 Hi-MiniDisc recorder, 1 recorder @ $145 ea. | $67.00 (Pro-rated; 1-yr lifespan) | | † | | | |
| | Garmin nuvi 255, 1 GPS navigator @ $230 ea. | $235.00 | | | | $235.00** | |
| | Sony Hi-MD blank minidiscs (1GB), 20 discs @ $10 ea. | $200.00 | | | | $100.00** | $100.00** |
| | Kingston 1GB memory card, 4 cards @ 15 ea. | $60.00 | | | | $30.00** | $30.00** |
| | Petzl Tikka Plus head lamp, 2 head lamps for $35 ea. | $70.00 | | | | $70.00** | |
| | AA Batteries 32-pack | $ 28.00 | | | | | $28.00** |
| **Computer Supplies** | PC laptop/Windows | $700.00 | | | | $700.00** | |
| | External hard drive | $200.00 | | | | $200.00** | |
| | SPECT'R v3.0 software (Binary Acoustic Technology) | $200.00 | | | | $200.00** | |
| | SPSS software v.17 | $425.00 | | † | | | |
| **Total** | | $9,117.80 | † | † | † | $3,012.00 | $2,978.80 |

Sources of funding

| Source | Full Name | Status |
|---|---|---|
| BRF | Black Rock Forest (through Small Grants program) | Requesting funding |
| CBC | Center for Biodiversity and Conservation (through AMNH) | Requesting funding |
| NABCF | North American Bat Conservation Fund (Bat Conservation International) | Requesting funding |
| NYCBG | New York City Bat Group | Labor confirmed |
| NRG | Natural Resources Group/NYC Dept. of Parks & Recreation | Labor confirmed |

Justification for Funding

Funding support provides the means to improve our base of knowledge about bat ecology in an increasingly urbanizing world and to adjust effectively our management actions to conserve local biodiversity. In addition, results from this project will represent the first inclusion of a North American bat survey in the collaborative iBats global initiative, aiding in the stride to monitor long-term trends in bat populations worldwide and in the spread of a global systematic surveying protocol. Similarly, the surveys undertaken in this project represent novel sites not incorporated in the New York State Department of Environmental Conservation's surveying plan. New collaborations with local and state agencies yield strong support for the proposed study and the direct turnover of study results to the appropriate managers and policy makers. The project is further strengthened by the volunteer base committed to the success of a systematic survey of bats in New York City and the surrounding region. Moreover, the implementation of this study provides a unique opportunity to develop a foundation wherein to promote public awareness of local environmental issues, particularly with respect to threats to bat persistence in the New York metropolitan area.

## APPENDIX

Summarizing Report for 2008 Study at Black Rock Forest

The authors would like to express their sincere gratitude for the generous funding from the Black Rock Forest Consortium. The support played a vital role in the execution of the first systematic bat acoustic survey in the New York metropolitan area. Funds were used to purchase critical equipment and supplies, provide a summer stipend to a postdoctoral associate, and support transportation costs to and from Black Rock Forest.

Black Rock Forest was acoustically surveyed for the presence of bats on six occasions between May and October in 2008. The implementation of the time-expansion detection protocol, as described in the project proposal, was successful. The mobile survey followed a hairpin looped transect (driven at 10mph following recommendations) that commenced half an hour after sunset in Glycerin Hollow, continued past Jim's and Sutherland Pond and the Stone House, and terminated approximately 50 minutes later near the Upper Reservoir (Figure 2). GPS track point data were recorded during the surveying period to document the driven transect and georeference echolocation calls. Acoustic signals were collected and recorded during each visit using a mounted detection kit. Sonograms of recorded echolocation pulses were visualized as expected (Figure 3).

Several characteristics of individual bat calls will be considered in this study to distinguish bat vocalization from non-bat calls and to assign calls to species or species group. Sonograms will be evaluated for overall call shape, call duration, interpulse interval, and maximum, minimum, and peak frequencies. These parameters have been demonstrated to be effective to classify calls. Evaluation of echolocation calls (e.g. species identification) and their relation to environmental and habitat variables (e.g. habitat use and ecological niche modeling) is ongoing. A thorough report will be submitted upon completion of the analysis and interpretation of the results.

Figure 1.

Distribution of the acoustic survey sites in the New York metropolitan area. All sites (1-9) will be surveyed in 2009: 1-Central Park, 2-Pelham Bay Park South, 3-Forest Park, 4-Prospect Park, 5-Black Rock Forest, 6-Staten Island Greenway, 7-Ringwood State Park, 8-Sterling Forest State Park, 9-Mianus River Gorge Preserve. Blue circles (1-5) represent sites surveyed using the TE detection system in 2008. Red triangles (6-9) represent new sites added to the study to be surveyed in 2009.

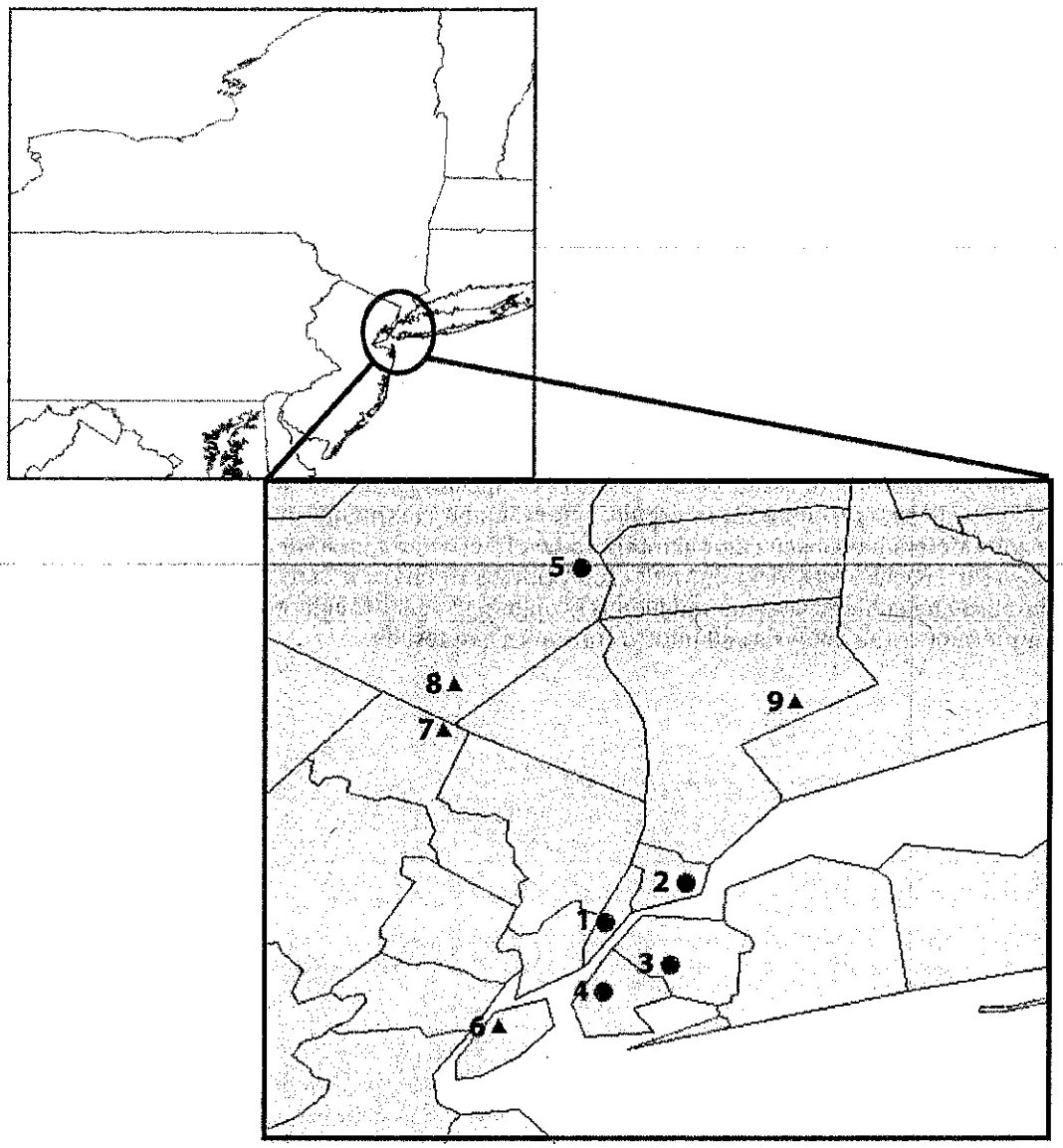


Figure 2.

Visualization of the transect route driven during each acoustic survey at Black Rock Forest May to October 2008. Surveys began at a midpoint in Glycerin Hollow and terminated near the Upper Reservoir.

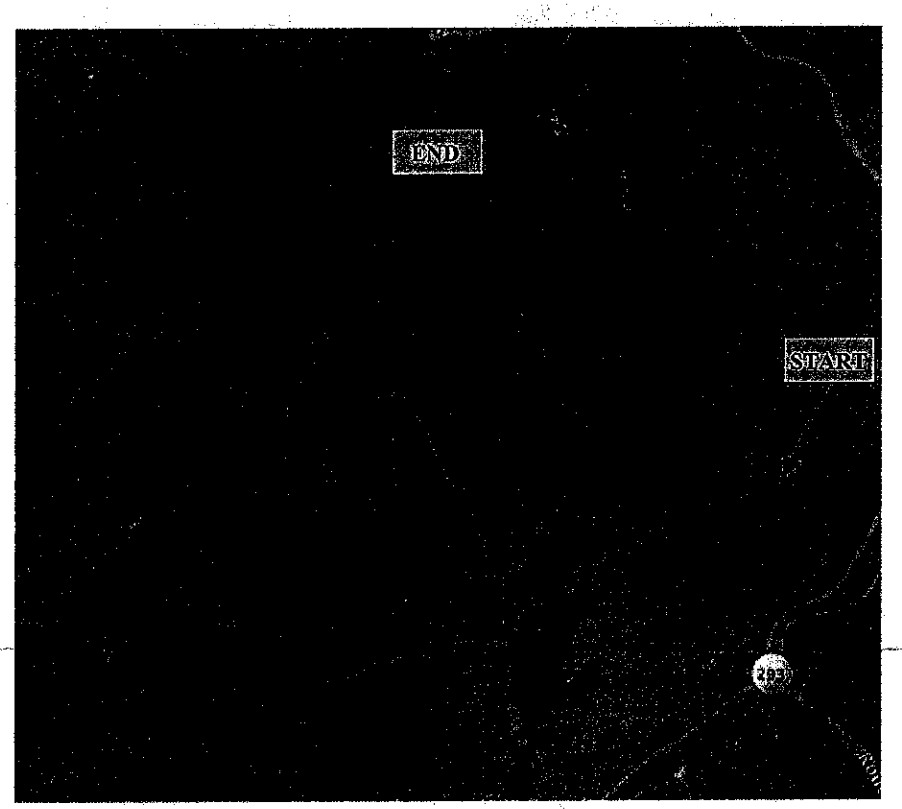
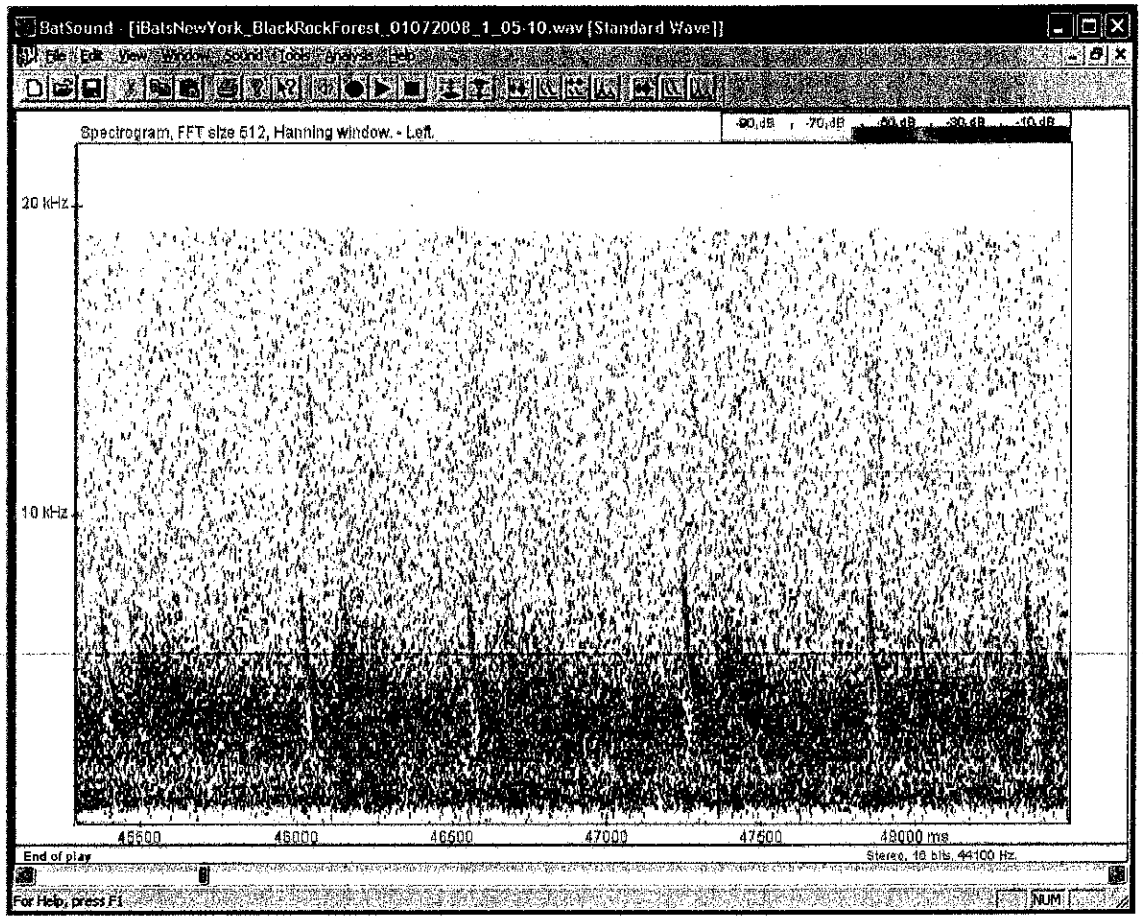


Figure 3.

Sonogram of a series of six bat echolocation vocalizations recorded during a mobile survey at Black Rock Forest on 01 July 2008.



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