PROGRESS REPORT
for
COOPERATIVE BOBCAT RESEARCH PROJECT

Period Covered:
1 October – 31 December 2013

Prepared by

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5 February 2014
SUMMARY BY STUDY OBJECTIVES

OBJECTIVE I -- DEVELOP PROTOCOL TO ESTIMATE CURRENT ABUNDANCE OF BOBCATS AND TRACK POPULATIONS STATEWIDE.

Approach #1: Use of transmitter-equipped bobcats to model suitable habitats and generate density estimate based on area requirements.

A draft copy of Gregory Reed’s MS thesis was provided in the previous report and a final copy was subsequently submitted. Chapters II and IV of that document addressed these topics.

Approach #2: Development of a method to monitor abundance of bobcat populations based on trail cameras and citizen scientist volunteers.

Trail Camera Surveys – Volunteers were recruited for trail camera surveys of bobcats through a press release by NHFG and an announcement on the project website. An email account was created to manage communication with volunteers (mail.google.com). The address (unhbobcat@gmail.com) was provided in the press release and on the project website. Training sessions for volunteers occurred on October 23rd in Concord, on October 24th in Brentwood, and on October 26th in Keene. At each session, volunteers were provided with attractants and a basic protocol that included a diagram of camera station setup (Box 1). Cameras with locks were loaned to volunteers that had requested to borrow them. A demonstration of camera station setup was followed by a question and answer session. Questions and issues that were raised were addressed in an amended protocol and emailed to all volunteers. Plastic storage bins containing prepared attractant kits for all volunteers who had missed training sessions or signed up after training sessions were placed at the NH Fish & Game offices in Concord and Keene on November 16th, and to the UNH Cooperative Extension office in Brentwood on November 17th. Before each survey, volunteers were asked to select a 13.33 km² survey unit from one of three study area maps for each camera they wished to deploy (Figure 3 of Litvaitis et al. 2013a). During the first two surveys, volunteers were emailed with maps that indicated the survey status of each unit (Fig. 1). Volunteers were encouraged to select units that were not currently being surveyed and had not previously been surveyed. Surveys began on November 1st and continued through December 16th (see Timeline in Box 1). There were at least 66 total participants out of >76 individuals who emailed to sign up for or express interest in participating in the study.

For each survey, volunteers were asked to report the study area, survey unit, make and model of the camera, deployment and collection dates, geographic coordinates of the camera, a written description of the camera’s location, comments on camera settings, and confirmation that the protocol was followed. As of January 17th, records existed for 220 proposed camera surveys that included a volunteer’s name and claimed survey unit. Of these, photos were received for 162 successfully completed camera surveys. Photos were received for 13 surveys that were unsuccessful due to incorrect camera positioning, camera malfunction, and unaccounted for images missing from submitted photograph sequences. Photos were never received for 45 of the proposed surveys. Some of these surveys were completed, others never occurred, and others have unknown status due to lack of communication from volunteers. In most cases photos were submitted over the Internet via Dropbox (www.dropbox.com). Some volunteers chose to mail in a CD or memory card of their photos.
Protocol for the 2013 New Hampshire Bobcat Surveys

University of New Hampshire in cooperation with New Hampshire Fish & Game Department
Prepared by Tyler Mahard

Thank you for your assistance with the 2013 New Hampshire Bobcat Surveys. This study is part of an ongoing cooperative project of the New Hampshire Fish & Game Department and the University of New Hampshire. This fall into winter, we will be gaging bobcat abundance through camera surveys in three large regions of New Hampshire. These are the southwest corner (Study Area A), the region west of Concord (Study Area B), and the southeast corner (Study Area C). We will be comparing bobcat abundance estimates from upcoming camera surveys to those from deer hunter surveys, public sightings, and road mortalities for these three regions. This will help us assess the validity of using these indexes to monitor bobcat abundance.

Monitoring any wildlife population informs us of its status and can alert us to potential problems in ecosystems. It also provides us with a better understanding of the function of natural systems and their interactions with human systems. Through better understanding, human activities can be guided in such a way that both people and wildlife can coexist in harmony.

The purpose of this protocol is to ensure standardization of camera and attractant setup among all volunteers participating in the survey. If there were variation in the attractants used at each camera station, these variations could influence the number of bobcat photographs produced. This would limit our ability to interpret the number of bobcat photographs as a reflection of actual bobcat abundance of a particular area.

We will be providing three attractants to be used at camera stations in this study:

1. Skunk lure – Intended to lure bobcats from a long distance
2. Pie tins – Intended to act as a visual stimulus
3. Catnip oil – Intended to encourage bobcats to spend more time in front of the camera

These attractants have been used successfully in other scientific studies of bobcats.

The following pages will explain how to select a location for the camera station and arrange these attractants.
Selecting a location

The location of your camera station should be a wooded area. We would like to remind volunteers to be aware of hunting season. Please wear orange, and do not enter the woods if you feel unsafe doing so. Remember that it is not necessary for cameras to be deep into the woods, although that works fine, 20 paces or so from an edge works as well. We encourage use of camera locks, especially when placing cameras on property that is not your own. We can recommend affordable locks to you. If you are placing your camera on property that is not owned by you, we ask that you obtain landowner permission.

Please see the diagram on the following page for details of camera station setup. You should select a location with tree structure that allows for this setup. Dimensions are approximate, so finding a location should take less than a few minutes to accomplish.

Before and after you set up your camera station according to the diagram on the next page, please run through this checklist:

- Stick with zip-tied catnip wick and cup roughly 5 large paces (or 5-6 yards) from camera
- Pie tin suspended above catnip stick at approximately 4-5 feet from ground
- Use only ⅓ of the skunk lure in the container per 14-day survey period
- Skunk lure is smeared on a tree that is behind other lures and in view of camera lens
- One smear of skunk lure is below knee height; the other is above head height
- Camera is centered on attractants and properly angled both left to right and up and down
- Kneel down behind the cup and align it with the camera lens by eye
- Camera is approximately 12-15 inches above the ground
- Camera is set to timestamp photos with the correct date and time
- Camera is set to capture still images when triggered by motion
- Image resolution should be 5 to 8 MP, if possible
- Please use your discretion and knowledge of your camera when setting sensitivity, we recommend medium sensitivity to those unfamiliar with their cameras
- If possible, set your camera to take 3 photos per trigger and opt for a smaller interval between photo captures (20 seconds or less) if this is possible on your camera
- Clear away any small vegetation or branches directly in front of the camera that may trigger photographs in windy conditions
- Camera is turned on and collects photographs when you walk between it and the attractants
CAMERA STATION
DIAGRAM

CAMERA
12"-18"

5 to 6 yards

CUP + CATNIP

PIE TIN

SKUNK LURE
GLOBS

STICK USED TO SMEAR SKUNK LURE

Apart from cup, measurements may be estimated.
Project details

- Each volunteer will set up a camera station in one or more survey units within a study area
- We are attempting to have one camera station in each survey unit
- Surveys will last 14 to 17 days
- We ask that each volunteer complete two surveys (additional surveys may occur)
- For subsequent surveys, we recommend that the camera be moved to an unoccupied survey unit, or to a different location within the assigned survey unit, if feasible
- We request GPS coordinates of the camera’s location (these may be obtained from a handheld GPS unit, most automobile GPS units, or from maps.google.com, email UNHbobcat@gmail.com for assistance)
- We would like all photographs collected during camera surveys
  - Preferably, this will occur through an internet dropbox, or memory cards may be mailed to UNH and will be returned to you
  - Data coincidentally collected on other species will be useful in other research

Timeline

October 23 - 31: Training sessions & attractant distribution

November 1 - 4: Deploy cameras to commence Survey 1

November 15 - 16: End Survey 1, commence Survey 2

November 29 - December 2: End Survey 2, commence Survey 3

December 13 – 16: End Survey 3

Box 1. Camera survey protocol. “Skunk lure” refers to Caven’s “Gusto” Long Distance Call Lure (Minnesota Trapline Products, Inc.). “Catnip oil” refers to Catnip Oil Imitation (F&T Fur Harvesters Trading Post, Alpena, MI).
Figure 1. Example study area map emailed to volunteers to encourage even camera distribution. This map was emailed to volunteers during Survey 2 to guide selection of survey units for Survey 3. Red slashes indicate units surveyed during Survey 2. Green circles indicate units surveyed during Survey 1. Volunteers were encouraged to sign up for unmarked units for Survey 3.

Trail Camera Survey Results – Of the 162 successful surveys with submitted photos, 14 contained confirmed bobcat images. A detection event was counted for each sequence of bobcat photographs in which all bobcat images were separated by < 0.5 hours from other bobcat images. Only one camera produced > 1 bobcat detection event during one survey (study area B). Detection rate was calculated as the number of bobcat detection events per trap night (i.e., 24-hours of surveillance by one camera, cumulative for multiple cameras) (Table 1). The number of successful trap nights per survey was ambiguous in some cases. If a survey produced no images during a given time period, it was not possible to determine whether or not the camera was functioning properly. Although volunteers were asked to submit all images, photos from many surveys lacked images taken during camera setup and deployment. These images were either removed by the volunteer or never captured. Further, there are several survey records that include date-stamped photos of the attractant setup that are a day or more before or after the reported deployment and collection dates. In these cases, it was not always possible to determine whether the volunteer reported incorrect dates or if the camera was incorrectly set. Contacting volunteers in an effort to correct erroneous information was often time-consuming and unsuccessful. Due to uncertainty in the number of successful trap nights, a range was calculated for each survey (Table 1). The lower bound of each trap night range is the summation of differences (in days) between the date stamps on the first and last photo for each survey. Surveys for which images were received from only one day (n = 10) were assumed to have...
produced 1 successful trap night. The number of trap nights for surveys in which date stamping malfunctioned or self-reset (n = 4) was taken as the number of day/night transitions in the photo sequence. The upper bound of each trap night range is the summation of differences (in days) between the reported deployment and collection dates for each survey. If either deployment or collection date was not reported, the missing date was assumed to be the first or last day of the survey period, respectively (n = 7 surveys). If neither deployment nor collection date was reported, survey duration was assumed to be the survey period length, 17 days (n = 5 surveys). Detection rate ranges were calculated as the number of detection events divided by the maximum (for detection rate lower bound) and minimum (for detection rate upper bound) number of trap nights.

<table>
<thead>
<tr>
<th>Study area</th>
<th>WMU</th>
<th>Surveys</th>
<th>Trap nights</th>
<th>Detection events</th>
<th>Detections / 100 trap nights</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>H2S</td>
<td>38</td>
<td>442 - 540</td>
<td>3</td>
<td>0.56 - 0.68</td>
</tr>
<tr>
<td>B</td>
<td>I2</td>
<td>60</td>
<td>646 - 855</td>
<td>8</td>
<td>0.94 - 1.24</td>
</tr>
<tr>
<td>C</td>
<td>M</td>
<td>64</td>
<td>666 - 848</td>
<td>4</td>
<td>0.47 - 0.60</td>
</tr>
</tbody>
</table>

Investigating agreement between abundance indices – There was an obvious correlation between camera detection rates and hunters’ observation rates of bobcats (R = 0.93, Figure 2). Although this result is based on a modest number of bobcat detections (n = 15), it is evidence that the two indices agree on the direction of the bobcat abundance gradient across these three WMUs. There was no correlation between camera detection rates and average habitat suitability (based on Reed’s (2013) telemetry-based model) of each study area (R = -0.08). Further analysis will use a t-test in an effort to support the hypothesis that HSI values of locations at which cameras detected bobcats were greater than those at which cameras did not detect bobcats. Significant results will suggest that bobcats are more easily detected in areas of higher suitability as indicated by the model. Hunters’ observation rates and the average HSI values of each study area were weakly correlated (R = 0.29). This could be explained by a difference between the average HSI values of each study area and the average HSI values of the regions in each WMU most frequented by hunters.

Further analysis will investigate correlation between hunters’ observation rates, incidental observations from the public, and HSI values of all WMUs for which a sufficient quantity of hunter survey data exists. Analysis may be repeated using townships, township clusters (i.e., multiple adjoining townships), and counties, provided that enough hunter survey data is available from each spatial unit. Defining spatial units by political boundaries allows for standardization of incidental observations by human population. This should reduce the influence of spatial variation in the number of potential observers on this index, yielding a better representation of bobcat abundance.
Figure 2. Correlations between bobcat detection rates from camera surveys, hunters’ observation rates of bobcats, and average habitat suitability index (HSI) values for each study area. Detection rates (detection events per 100 trap nights) are the average of the upper and lower bounds of detection rate ranges reported in Table 1. Hunters’ observation rates of bobcats (bobcat observations per 1000 hunting hours) are from NHFG hunter survey data as summarized by Litvaitis et al. (2013b). ArcGIS 10.0 (ESRI, Redlands, CA) was used to calculate average HSI values. This was taken as the average HSI value of all raster cells on a model of bobcat habitat suitability (Fig. 2-7 of Reed 2013) that was spatially coincident with each study area. HSI was on a scale of 0-1, with 1 being most suitable. Data points are symbolized by study area letter and lines of linear fit are shown. R values are reported in the bottom right corner of each chart.
Approach #3: Evaluate the application of population genetics using tissue from road-killed bobcats.

Genomic DNA has been extracted from 123 spatially referenced bobcat tissues obtained in New Hampshire (19 live-trapped and 104 road kill). These samples will be genotyped at 18 unique microsatellite loci (Carmichael et al. 2000; Faircloth et al. 2005; Menotti-Raymond et al. 1999, 2005). To date, 98 of the samples have been successfully genotyped at 13 loci.

Preliminary analysis was conducted on the genotyped samples. The program STRUCTURE showed a moderate level of population structuring and the optimal number of subpopulations was determined to be five. A Mantel test suggested that genetic distance was not positively correlated with linear distance for individuals in the study area (p = 0.002). Each individual was assigned to a deme based on locations separated by potential barriers including major roads (Interstates 89 and 93, highways 2, 4, and 9), the White Mountains, and Lake Winnipesaukee. Pairwise genetic distances were calculated between each deme, and again isolation by distance (IBD) did not explain the variation in allelic frequency. The two most genetically distant regions were centered on Keene in southwest New Hampshire and Raymond in the southeast portion of the state, a linear distance of only 80 km that contains the I-93/Everett Turnpike corridor. A G-test of population differentiation returned a highly significant (p = 0.0002) level of differentiation between these two demes.

Analysis of all individuals indicated an overall heterozygote deficiency (observed $H_o = 0.64$, expected $H_e = 0.74$), with demes in southwest and northern NH showing the greatest deficit. Furthermore, elevated levels of inbreeding were found in demes in southwest NH and north of the White Mountains. The latter is an intriguing find considering that although snow cover and elevation associated with the mountains may effectively cut off northern and southern populations in New Hampshire, there is no obvious barrier to movement into vast potential habitat areas in Maine and Quebec.

State borders do not effectively restrain the bobcat population in New Hampshire. Additionally, because New Hampshire is the only New England state with no harvest season, it may have served as a source population to neighboring territories. Therefore, to analyze the broader, regional population dynamics, tissue samples have been solicited from authorities in Maine, Massachusetts, Vermont, and Quebec, Canada and are forthcoming. It is estimated these samples will augment the study by 120-150 individuals and allow for more robust landscape genetic analysis.

OBJECTIVE II -- COMPARE ABUNDANCE OF BOBCATS IN NEW HAMPSHIRE TO POPULATIONS IN ADJACENT STATES.

Chapter IV of the Gregory Reed’s thesis addressed this objective.

OBJECTIVE III -- IDENTIFY POTENTIAL WILDLIFE CORRIDORS.

Chapter III of Gregory Reed’s thesis addressed this objective.
LITERATURE CITED


