PROGRESS REPORT

for

COOPERATIVE BOBCAT RESEARCH PROJECT

Period Covered:

1 June – 31 December 2010

Prepared by

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SUMMARY BY PROJECT OBJECTIVES

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

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

A. Location data

Of the 12 adult bobcats equipped with radio collars, 11 have provided sufficient information on movements to examine habitat use and area requirements (Appendix A). The 8 bobcats fitted with Sirtrack GPS collars were monitored by ground and aerial telemetry. Recent flights also revealed if these collars had deployed their automatic drop-off mechanism. To date, 7 have been recovered of which 5 successfully dropped off and 2 others were recovered by recapturing the bobcats (Table 1). The remaining collar on female #35 has dropped off (this bobcat was recaptured without a collar), but its VHF signal has not been detected. The other 4 animals equipped with Lotek GPS collars are still wearing their collars. Cooperating trappers are currently attempting to recapture these animals. Trappers have been provided with maps illustrating individual home ranges and core areas to help focus their efforts.

Table 1. Period monitored and number of locations obtained (in several categories) for 11 bobcats in southwestern New Hampshire.

Collar Type	Bobcat ID	Deployed	Days Functional	Expected Fixes[a]	2D & 3D Fixes	After Screening (Data Retention)	Percent Useable[b]
Lotek	26	22-Nov-09	261	1305	919	860	65.9
Lotek	27	13-Jan-10	245	1225	970	848	69.2
Lotek	28	16-Jan-10	135	675	453	433	64.1
Lotek	30	3-Feb-10	215	1075	748	705	65.6
Sirtrack	29	19-Jan-10	224	768	301	233	30.3
Sirtrack	31	13-Feb-10	199	682	128	94	13.8
Sirtrack	32	13-Feb-10	199	682	265	205	30.0
Sirtrack	33	22-Feb-10	190	651	115	89	13.7
Sirtrack	34	1-Mar-10	288	987	529	416	42.1
Sirtrack	39	8-Mar-10	292	1001	484	381	38.1
Sirtrack	40	12-Mar-10	204	699	418	319	45.6

[a]Assuming every attempted GPS fix was obtained over the duration of operation and full data retention (e.g., DOP $\leq$ 5.0). Sirtrack: [(days operational x 24 hours a day)/7 hour fix schedule]. Lotek: (days operational x 5 fixes per day)

[b]Retained/expected.

Prior to ordering additional collars, we compared location data obtained from both collar configurations. Lotek collars functioned from 135 to 261 days after deployment, and yielded 453-970 locations each (Table 1). Sirtrack collars functioned from 190 to 292 days after deployment and yielded 115-529 locations (Table 1). A procedure was used to screen inaccurate locations by removing those that were obtained by only using 3 satellites (i.e., 2D fixes) and had a dilution of precision (DOP) value of >5.0 (Lewis et al. 2007). This technique removed as much as 13% of locations obtained from Lotek collars and 27% of locations from Sirtrack collars (Table 1). From these comparisons, we concluded that Lotek collars consistently outperformed those produced by Sirtrack. After screening, locations summed 4,583.

B. Habitat selection

GIS layers for New Hampshire and Vermont have been collected and edited in preparation for habitat selection model construction. This includes combining land cover variables from the 2001 New Hampshire Land Cover Assessment dataset (NHLC) into variables relevant to a bobcat. Some concern has arisen upon examining the NHLC, as many land cover types are grouped into the same category and hence, identified as the same land cover type. For example, a timber harvest that occurred shortly before the images taken for the NHLC were taken is identified as "disturbed" land cover. Disturbed land cover in the study area is most often associated with human development. Efforts will be made to determine if these regenerating cuts can be identified separately from other disturbed areas. Other GIS sampling tools have been identified for use in generating random points within designated areas to serve as available habitat measurements in a used-available resource selection function (Manly et al. 2002).

Although a habitat model has not yet been constructed, some patterns of selection seem apparent. During winter, bobcats seem to be selecting wetland areas. This selection was reinforced by observations made in the field during winter scat surveys. In summer, bobcats seemed to shift to areas with an abundance of agricultural fields. Additionally, some bobcats are frequently associated with regenerating forest stands. Bobcats are also avoiding major roadways, including Routes 9, 12, and 101.

C. Initial estimate of bobcat density based on area requirements

Home ranges were calculated using a fixed kernel estimator with least-squares cross validation (Worton 1989, Seaman and Powell 1996, Millspaugh et al. 2006) and the Home Range Extension for ArcView software (Hooge and Eichenlaub 1997). Home ranges were estimated using a 95% utilization distribution (UD)while core areas were based on a 50% UD (Powell 2000, Tucker et al. 2008; Fig. 1). Seasonal home ranges spanned temporal periods that likely affect bobcat movements, including: 1 November – 31 March (Winter), 1 April – 15 June (Spring), 16 June – 31 October (Summer/Autumn). A minimum of 30 locations were used to estimate seasonal home ranges (Seamen and Powell 1996).

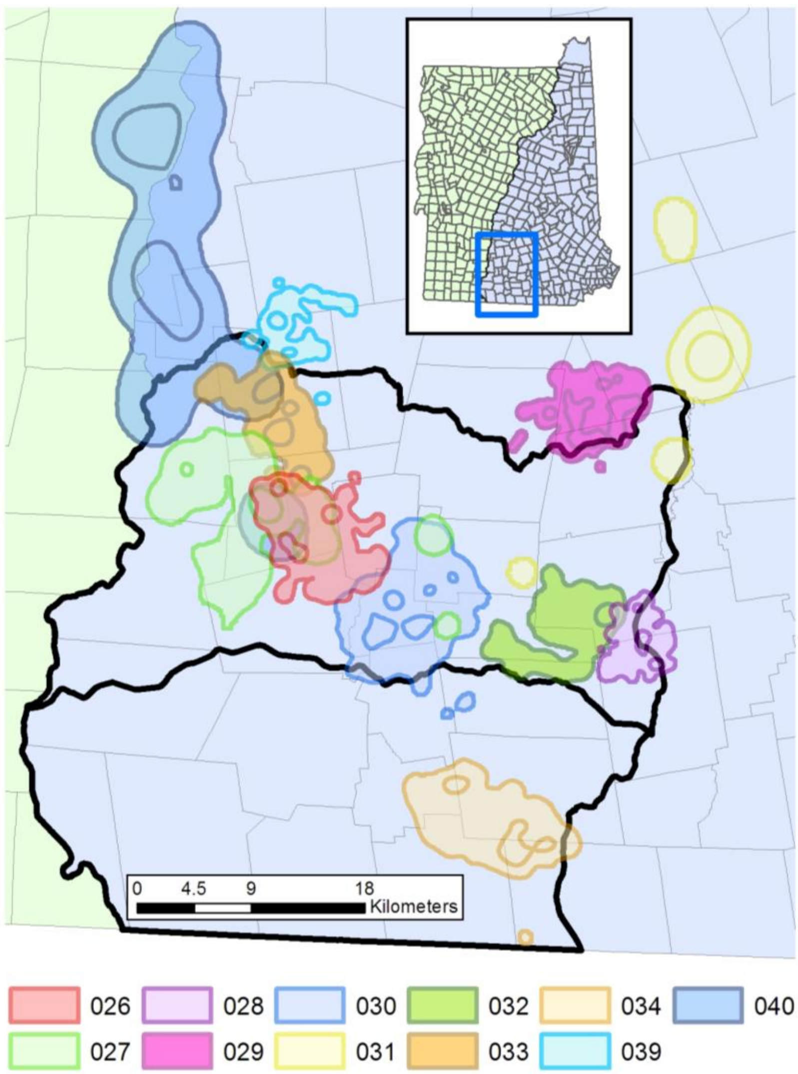

Figure 1. Composite home ranges (95% utilization) and core areas (50% utilization) for 11 adult bobcats in southwestern New Hampshire.

Table 2. Composite and seasonal home ranges (with associated core areas) for 11 bobcats in southwestern New Hampshire.

			Winter 2009		Spring 2010		Summer/Autumn 2010		Winter 2010		Composite	
ID	Sex	UD*	Km²	Locations	Km²	Locations	Km²	Locations	Km²	Locations	Km²	Locations
26	Male	95	48.79	410	66.76	258	99.12	192	.	.	72.59	860
		50	3.48		2.24		4.11		.		5.26	
27	Male	95	76.20	187	230.14	283	34.29	378	.	.	126.59	848
		50	10.59		13.65		2.92		.		5.72	
28	Female	95	24.68	258	31.34	175	N/A	N/A	.	.	29.69	433
		50	1.54		2.17		N/A		.		2.47	
29	Male	95	56.69	60	48.24	101	49.22	72	.	.	54.37	233
		50	9.45		8.46		15.07		.		14.03	
30	Male	95	59.04	164	81.51	251	116.71	290	.	.	103.05	705
		50	6.99		6.70		17.66		.		9.79	
31	Male	95	.	.	.	.	61.57	94	.	.	61.57	94
		50	.		.		10.45		.		10.45	
32	Male	95	45.39	34	87.16	81	37.62	90	.	.	56.41	205
		50	4.57		17.61		2.59		.		2.33	
33	Male	95	54.99	31	45.35	39	66.40	19	.	.	59.83	89
		50	8.11		4.69		13.43		.		9.98	

Table 2. Continued

Bobcat ID	Sex	UD*	Winter 2009 Km²	Winter 2009 Locations	Spring 2010 Km²	Spring 2010 Locations	Summer/Autumn 2010 Km²	Summer/Autumn 2010 Locations	Winter 2010 Km²	Winter 2010 Locations	Composite Km²	Composite Locations
34	Male	95	53.50	43	81.30	102	90.50	198	83.02	73	80.18	416
		50	7.21		11.33		26.37		10.19		8.59	
39	Male	95	30.93	19	23.70	111	36.70	185	39.75	66	28.69	381
		50	8.27		2.03		4.28		3.87		1.85	
40	Male	95	45.44	37	180.43	134	214.90	148	.	.	292.07	319
		50	3.29		17.88		27.95		.		47.80	
Totals				1243		1535		1666		139		4583

An initial estimate of adult bobcat abundance within the study area was generated using a straight-forward approach. Essentially, we estimated the number of male and female home ranges that could fit within the study area after adjusting for overlap among neighboring home ranges. For males, 9 different overlap events were measured with a mean of 10.4 km^2. This was then subtracted from the average male home range yielding an area requirement of 83.2 km^2. Next, we assumed that female home ranges overlapped by half the percentage of male home ranges, resulting in an estimate of 5.5% overlap. Dividing these adjusted area requirements into the study area (1,862 km^2) yielded an estimate of 88 adult bobcats (22 males and 66 females). Again, this estimate is an approximation that will be modified as we construct a habitat model that will enables us to delete unsuitable habitat and thus reduce our estimate of bobcats in the area.

Field activities are currently being directed in our second study (Fig. 2) where our plan is to capture 6-10 adult bobcats. We anticipate that differences in habitat composition and road densities between the two areas will provide additional insights. Six Lotek collars were purchased and the 4 existing Lotek collars will be deployed if they are retrieved.

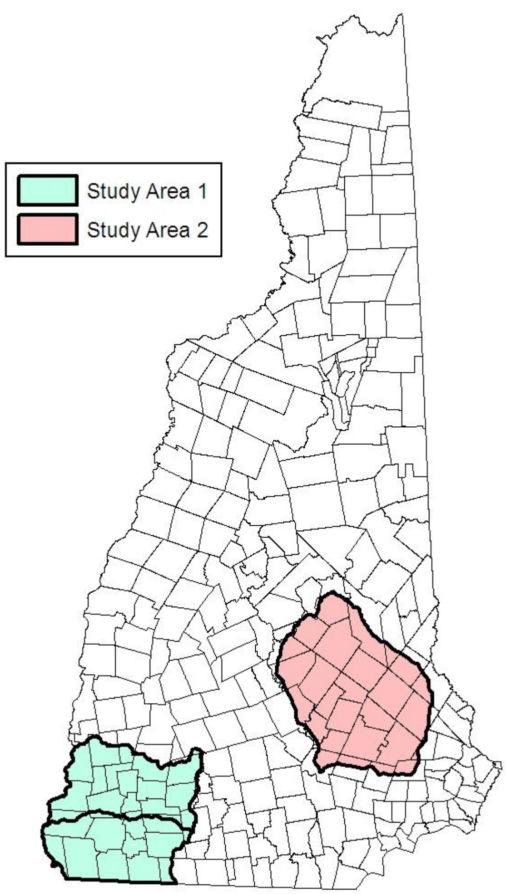

Figure 2. Two study areas used to investigate bobcat movements and habitat use in New Hampshire.

Approach #2: Evaluate methods (excluding telemetry) to monitor abundance of bobcat populations.

A. Use of fecal DNA in combination with mark-recapture estimators

Based on the results of our pilot effort (summarized in the previous Progress Report), we decided that this approach cannot be used to generate estimates of bobcat abundance or track changes in regional populations. The most obvious impediment to this approach is our ability to locate a sufficient number of bobcat feces.

B. Application of remotely-triggered cameras

We are currently evaluating the use of remotely-triggered cameras as bobcat census method. Because these cameras have become very popular with amateur naturalist, we are also considering ways to recruit volunteers in a large-scale effort to estimate bobcat abundance. If volunteers are used, it is likely they will bring with them a variety of cameras that have different configurations. We suspected that characteristics of a camera, especially trigger speed and detection zone, could affect the ability of the camera to consistently record animals that pass in front of it.

To evaluate the potential sampling bias associated with different camera configurations, we conducted paired comparisons with two popular cameras. Reconyx (model HyperFire) is a relatively high-priced camera (~$500) that has a large detection zone (324.1 m^2) and rapid trigger speed (1/5 second). On the other hand, Cuddeback (model Capture IR) is a less costly camera (~$150) and popular among naturalists and hunters, but has a substantially smaller detection zone (14.7 m^2) and slower trigger speed (1/3 second). Cameras were attached to a wooden frame that supported one Reconyx and one Cuddeback. Six pairs of cameras were then positioned in several areas, including known home ranges of bobcats in Study Area 1. Bobcat or coyote urine was used as an attractant and cameras remained in the field for 5-7 days before being moved to a new location. Our intent was not to determine how effective these cameras would be in photographing bobcats, but rather to determine if camera configuration influenced sampling efficiency.

We generated >300 "camera days" that yielded 150 unique photographs (Fig. 3). Reconyx cameras recorded more images for 8 of the 10 species sampled (Fig. 3). Differences in camera detections were most notable among carnivores and small to medium-sized mammals. Future evaluations may include efforts directed toward estimating local bobcat abundance using the methods described by Rowcliffe et al. (2008). This method does not require recognition of individual animals (as in a mark-recapture approach), but relies on information of sampling area (based on a camera's detection zone), duration of sampling period, and average rate of movement of the animals being sampled (based on telemetry data or published data). Also, cameras must be distributed in a random manner with no effort to attract (no bait or lure). The advantage of this approach is that it can be easily expanded and used to monitor a group of secretive species. The most obvious disadvantage is that it will likely require a substantial number of cameras.

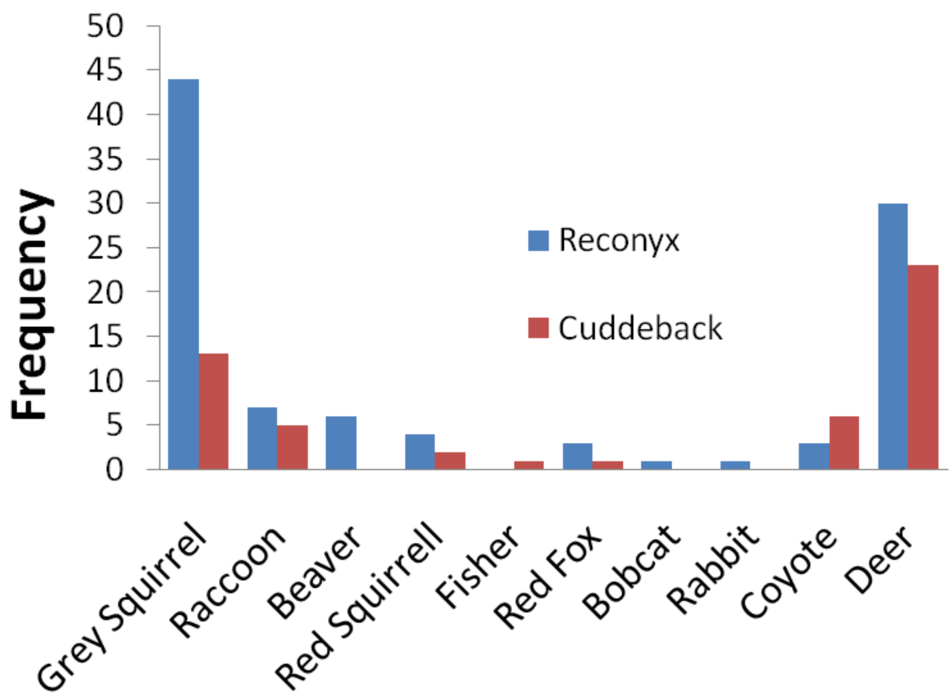

Figure 3. Comparison of the frequency of photographs obtained by Reconyx and Cuddeback trail cameras during side-by-side comparisons in southern New Hampshire, 2010.

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

Approach #1: Compare home range size of bobcats in New Hampshire to estimates from neighboring states.

The mean composite home range (all locations) for males (93.5 km ^{2}) in our study was comparable to estimates obtained from bobcats in neighboring Maine (Litvaitis et al. 1986) and Massachusetts (Berendzen 1985). Additional information is needed on adult females.

Approach #2: Solicit observations from the general public to estimate the distribution of bobcats within the state.

Since posting our web site that requested observations in a standard format, we have obtained 287 sightings (through 31 December 2010). As reported previously, these observation show that bobcats have become more abundant in the southeastern portion of the state.

OBJECTIVE III -- USE INFORMATION ON BOBCAT MOVEMENTS AND GENE FLOW TO IDENTIFY POTENTIAL WILDLIFE CORRIDORS.

Approach #1: Use location data obtained from radio-collared bobcats in conjunction with various spatial models (e.g., least-cost pathways) to identify potential corridors used by bobcats.

This topic and approach will be the major focus of the second graduate student involved with this project. Over 60 applications are being evaluated at this time.

Approach #2: Evaluate the application of landscape genetics using historic samples of bobcats.

In addition to using information from radio-collared bobcats, we are evaluating the application of landscape genetics to understand how specific landscape features may have influenced gene flow and ultimately the distribution of bobcat populations in the state. This approach relies on an examination of genetic variation among individual bobcats. Basically, variation increases with geographic distance or in response to obvious barriers to bobcat movements (e.g., large rivers, urban areas, and possibly high traffic volume roads). A fairly large sample is needed to use this approach and tissue samples are often obtained from carcasses of harvested animals. That approach is not possible in New Hampshire (trapping/hunting seasons closed >20 years). As a result, we are exploring the use of a historic sample, specifically the skulls of animals submitted for bounty payment that were collected by Dr. Clark Stevens (the first professor of wildlife management at UNH). These skulls came from animals harvested in the 1950s (Fig. 4).

To date, we have developed a method for extracting DNA from skull bones and teeth that has a better than 80% success rate. As is common for ancient DNA (aDNA) samples, the DNA is highly degraded and generally fragments are only about 200 base pairs long. This is even more pronounced in these skull samples because of their method of preparation (i.e., boiling of samples to remove tissue). At this point, we are exploring different molecular markers that can provide us with population-level information.

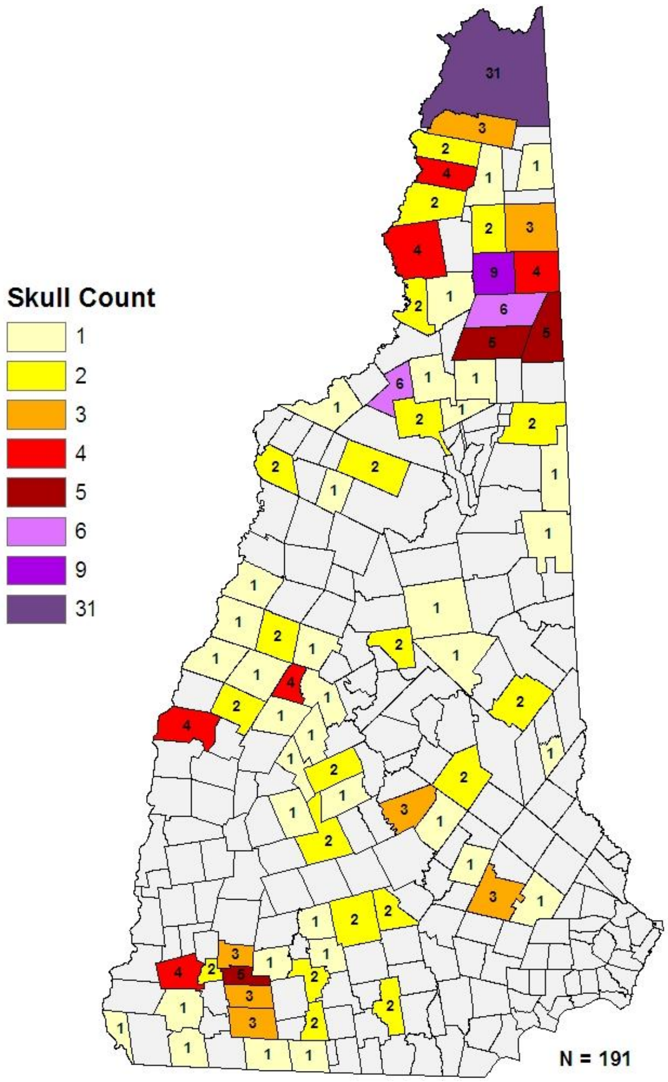

Figure 4. Distribution of bobcat skulls collected from animals submitted for bounty payment throughout New Hampshire during the 1950s.

Use of historic samples may provide a unique opportunity to examine how bobcat populations were structured prior to the construction of major state and interstate highways and a substantially lower human population. We may then be able to compare how bobcats are responding to contemporary landscapes based on telemetry data.

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Appendix A. Status of 12 adult bobcats equipped with radio collars in southwestern New Hampshire.

Capture Date	Town	Bobcat ID	Sex	Age Class	Recapture Date	Collar Type	Collar Recovery Date	Data Obtained	Last Known Status	Date of Last Known Status
11/22/09	Gilsum	26	M	A	.	Lotek	.	Y	Alive	08/10/10
01/13/10	Westmoreland	27	M	A	.	Lotek	.	Y	Alive	09/18/10
01/16/10	Hancock	28	F	A	02/16/10	Lotek	.	Y	Alive	10/01/10
01/19/10	Antrim	29	M	A	.	Sirtrack	09/26/10	Y	Alive	09/01/10
02/03/10	Nelson	30	M	A	.	Lotek	.	Y	Alive	09/01/10
02/13/10	Harrisville	31	M	A	.	Sirtrack	11/04/10	Y	Dead	09/01/10
02/13/10	Harrisville	32	M	A	.	Sirtrack	09/09/10	Y	Alive	9/6/2010
02/22/10	Alstead	33	M	A	.	Sirtrack	09/16/10	Y	Alive	09/01/10
03/01/10	Jaffrey	34	M	A	1/15/2011	Sirtrack	01/15/11	Y	Alive	12/14/10
03/06/10	Jaffrey	35	F	A	3/8/10, 11/12/10	Sirtrack	.	N	Alive	11/12/10
03/08/10	Alstead	39	M	A	12/25/2010	Sirtrack	12/25/10	Y	Alive	12/07/10
03/12/10	Walpole	40	M	A	.	Sirtrack	11/04/10	Y	Alive	10/03/10