Interim Progress Report

Research Title:

Population Status and Foraging Ecology of Eastern Coyotes in New York State

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Summary: The goals of this research are to estimate coyote abundance in New York State and evaluate the impacts of coyote predation on deer populations. Since 2007, our research has focused on intensive monitoring of radio- and GPS-collared coyotes in Steuben and Otsego Counties to estimate deer kill rates and evaluate alternative methods for estimating coyote population size. In summer 2010, we transitioned from focal-area surveys to broad-scale surveys of coyote abundance across the state. Intensive surveys of coyote population size were conducted at 3 new sites (western Adirondacks, Catskills, and Genesee County) using non-invasive genetic and site-occupancy approaches. To compliment these local studies, extensive, statewide surveys were conducted that combined call-response surveys with distance sampling during July-August 2010. A total of 541 points were surveyed statewide from which we estimated the probability of detecting a calling coyote to be 0.1985 (0.0268 SE). This, in combination with an expected 35% response rate based on previous literature and our own field tests, yielded a statewide estimate of 34,489 coyotes. This report provides details on this statewide study, progress on kill rate estimation, and scheduled completion dates for these analyses.

Progress

The following report summarizes the field and laboratory work that has been completed from May 2010 through May 2011.

Collared Coyote Monitoring and Mortalities

Of the 50 coyotes collared since the beginning of the study in 2007 (31 in Otsego and 19 in Steuben), 31 have died, 10 went missing due to dispersal or transmitter failure, 2 collars expired, 2 collars successfully dropped-off, and 5 drop-off units failed with subsequent battery failure (Appendix 1 and 2). We no longer have radio contact with any collars and we continue to cooperate with sportsmen during open hunting and trapping seasons to recover GPS collars that failed to drop off (3 in Otsego and 2 in Steuben).

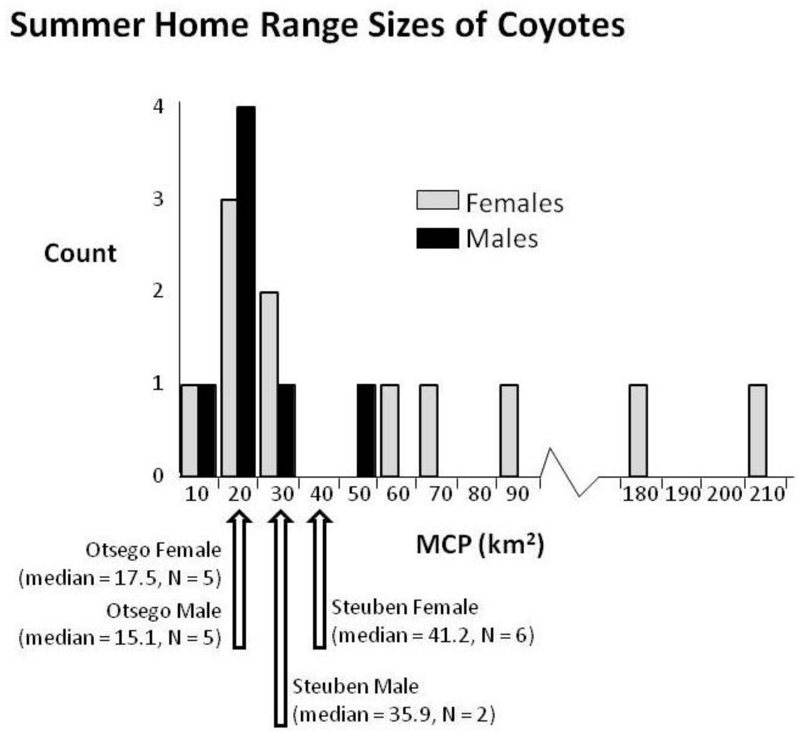
The causes of death of 31 coyotes (21 in Otsego and 10 in Steuben) included 7 shot by landowners, 5 shot by houndsmen, 5 trapped (4 local and 1 in Pennsylvania), 4 shot by deer hunters, 3 shot by predator hunters, 2 killed by vehicle strike, and 5 found dead (3 with hunting injuries, 1 with severe mange, and 1 unknown due to advanced stages of decomposition).

For our kill rate analysis (see section by Robin Holevinski) we deployed GPS collars on 19 animals (11 in Otsego County and 8 in Steuben County). These collars achieved a mean fix rate of 0.89 (0.05 SD), and 91% of the acquired locations were in the most accurate 3D mode.

Crude estimates of coyote density are typically derived based on patterns in home range size (the smaller the average home range size the greater presumed density of coyotes). We looked at summer home range sizes as a simple form of validation for our statewide population density estimates (see section by Sara Hansen). GPS locations collected June-August in each year were resampled to a 6-hr location schedule, which yielded on average 289 locations (115 SD) per coyote for home range analysis. Minimum convex polygon home ranges were constructed for each coyote using the HawthsTools extension in ArcMap. MCP size was highly skewed (see figure at top of next page), and so we report median home range sizes.

GPS-collared coyote in Otsego County.

Within a given study area, median home range sizes were similar between males and females. Overall, the median size of home ranges in Otsego County were less than half the size of home ranges in Steuben County. This indicates a higher density of coyotes in the Otsego County study area, which is consistent with our anecdotal observations from trapping encounter rates and success. The observation of higher coyote density in the Otsego study site (which overlaps the Mohawk River Valley) also concur with the geographic variation in coyote density observed in our statewide analysis (see section by Sara Hansen).



Deer Kill Rates (Robin Holevinski)

Field work to detect adult and fawn deer killed by coyotes ended in summer 2009, and this year progress was made on estimating kill rates. We used a 20-minute GPS fix interval during summer (to detect fawn kills), and a 1-hr fix interval in winter to model (to detect adult kills). We were successful at detecting kills with our field approach (see previous reports for details). Importantly, we were unable to visit every possible kill location for a given coyote, and thus must use our subset of visited kill (and non-kill) sites to model probable kills so as to derive a robust kill rate estimate for the duration of our monitoring periods. This process involves the following steps:

1. Identify potential kill sites based on patterns in the GPS collar data ("clusters") that indicate areas where coyotes spent time,

2. For a subsample of clusters visited in the field, use logistic regression to discriminate which clusters were probable kill or scavenging sites rather than some non-kill related behavior (i.e., bed, den, or rendezvous site). This model includes covariates representing time of day, Julian day, handling time (duration of stay in cluster), and the time lag between cluster development and field search (this relates to the probability of detecting a kill at a site), in addition to site-specific covariates like habitat type or road proximity.
3. Discriminate whether a probable kill site corresponds to a deer or other prey item (this step may be combined with step 2 or may require a separate step),
4. Validate the predictive power of the model using withheld data,
5. Apply the model to the remaining clusters that were not field-visited to determine the total number of probable deer kills during the sampled season and derive a kill-rate estimate per coyote.

To identify clusters (STEP 1), we employed an epidemiological software called SaTScan (Kuldorff et al. 2005) that relies on the spread of the sample points both in space and time to identify "clusters" of, in our case, GPS collar locations. For the 15 GPS-collared coyotes monitored between summer 2008 and 2009, SaTScan identified 2,245 clusters during our monitoring windows that ranged 0.3-6.7 hours in time and 0-50 m in radius. We field-visited a total of 595 of these clusters to record coyote activity at clusters (e.g., fawn kill site, bed site), and used 477 of these to parameterize our kill rate models (STEPS 2-3) withholding 118 clusters for model validation.

At the annual meeting this April we reported preliminary results for fawn kills modeled using a standard logistic regression model. This model was deemed inappropriate due to unequal sampling intensities and variation in kill rates among individual coyotes, thus we report here a generalized linear mixed effects model used to discriminate fawn kills (y=1) from any other behavior (y=0), including kills of other species. We fit a coyote-specific intercept (random intercept model), and selected the most parsimonious set of predictor variables from a set of candidate models that included survey, animal, cluster, site, and temporal covariates (see table to follow for description).

Variable	**Type**	**Description**
Survey covariates		
Year	Binary	2008 (y=1) versus 2009 (y=0)

Site	Binary	Otsego (y=1) versus Steuben (y=0)
Lapse	Continuous	Time (in days) between cluster development and field reconnaissance (to account for declining detectability over time)
Animal covariates		
Sex	Binary	Male (y=1) versus female (y=0)
Cluster covariates		
Time	Continuous	Consecutive time (in minutes) spent within cluster
Radius	Continuous	Radius of cluster in meters
Super	Binary	Whether or not this cluster was part of a "supercluster" or cluster of clusters
Site covariates		
Road	Continuous	Proximity of nearest road (of any type) in meters
Edge	Continuous	Proximity of nearest hard edge (forest:open) in meters
Forest	Continuous	Proximity of nearest forest cover in meters
Habitat	Categorical	Pasture, row crops, deciduous forest, evergreen forest, mixed forest
Temporal covariates		
Night	Binary	Splits the day between 2000 – 0300 hours (y=1) and 0300-2000 hours (y=0)
Julian	Continuous	Julian day spanning day 144 to 206

Alternative candidate models were fit using the GLLAMM function in Stata 9.0 (StataCorp 1985) and compared using AICc (Burnham and Anderson 1998) where the number of fawn kills (N=23) was set as the sample size for the small-sample bias correction. The highest ranked model included two survey covariates (year, lapse), one cluster covariate (radius), one site covariate (road), and two temporal covariates (julian, night; see table below).

Rank	Model	LL	K	AICc	ΔAICc	*w*
1	survey(2), cluster(1), site(1), temporal(2)	-70.91	8	158.13	0.00	0.39
2	survey(2), site(1), temporal(2)	-72.71	7	159.66	1.53	0.18
3	survey(1), cluster(1), site(1), temporal(2)	-72.84	7	159.92	1.79	0.16
4	survey(1), site(1), temporal(2)	-74.64	6	161.46	3.33	0.07

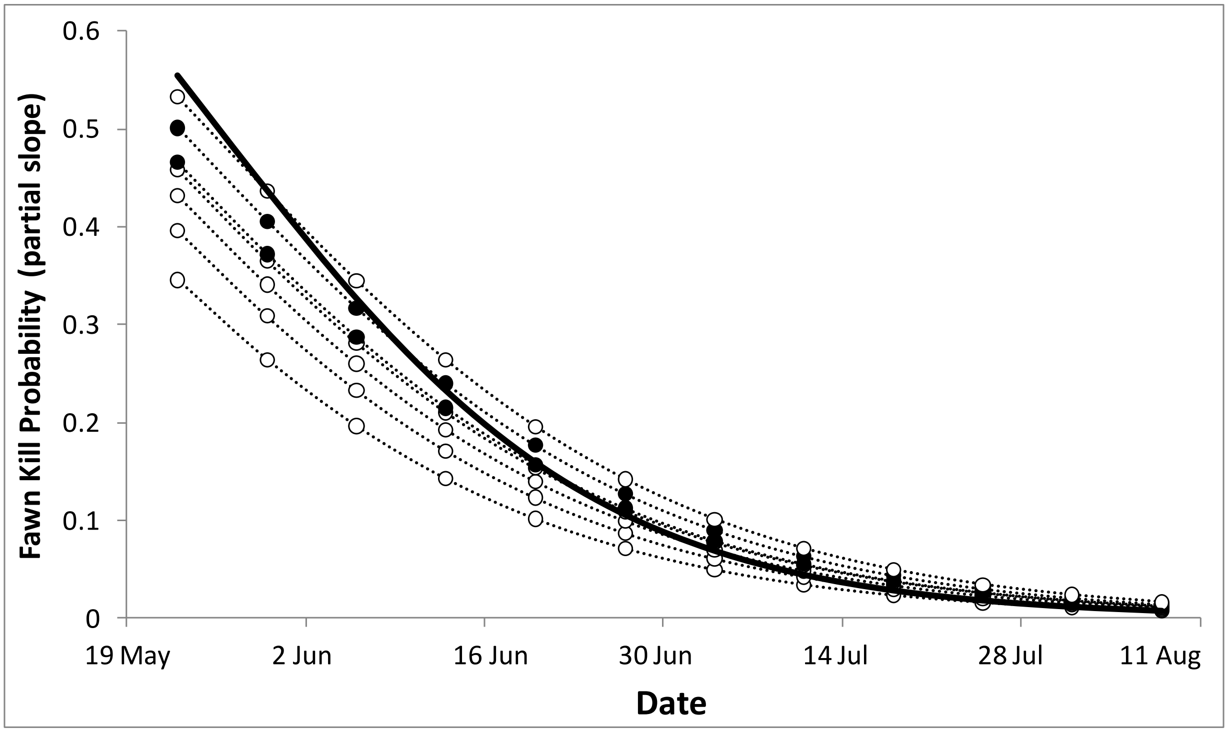
5	survey(3), site(1), temporal(2)	-72.65	8	161.61	3.48	0.07
6	survey(3), animal(1), cluster(3), site(4), temporal(2)	-66.06	15	163.16	5.04	0.03
7	survey(3), cluster(3), site(4), temporal(2)	-67.42	14	163.75	5.62	0.02
8	survey(3), animal(1), site(4), temporal(2)	-69.65	12	163.97	5.85	0.02
9	survey(3), animal(1), cluster(3), temporal(2)	-70.93	11	164.43	6.30	0.02
10	survey(3), site(4), temporal(2)	-71.16	11	164.89	6.76	0.01
11	survey(3), cluster(3), temporal(2)	-72.28	10	165.03	6.90	0.01
12	survey(3), temporal(2)	-76.48	7	167.20	9.07	<0.01
13	animal(1), cluster(3), site(4), temporal(2)	-71.29	12	167.25	9.13	<0.01
14	survey(3), animal(1), cluster(3), site(4)	-72.49	13	171.77	13.64	<0.01

Some model selection uncertainty surrounded the inclusion of either radius (model) or year (model 3), but removing both variables led to a significantly less well supported model. Thus, we chose model 1 (including both of these covariates) as our best model. This model was statistically significant (N = 476, LR $\chi^2 = 49.11$, $P < 0.01$) and had a moderate predictive ability based on the area under the ROC curve (AUC = 0.86), which is a measure of classification accuracy integrated across the range of possible probability cutoff values.

Our highest ranked model predicted a 5.4 times greater likelihood of a cluster being a fawn kill between the hours of 8 pm and 3 am (see table below). Moreover, the odds of a cluster being predicted as a fawn kill declined by 0.7 times every 7 days or with every 100 m away from a road, by 0.4 times for every 25-m increase in the spread of locations in a cluster, and by 0.9 for every day that elapsed between cluster development and field reconnaissance.

Variable	Coefficient	SE	*P*	Odds Ratio
Year (2008)	-1.7498	0.8985	0.051	0.1738
Lapse	-0.1427	0.0728	0.050	0.8670
Radius (in 25-m increments)	-1.0080	0.5347	0.059	0.3649
Road (in 100-m increments)	-0.3565	0.1362	0.009	0.7001
Julian (in 7-day increments)	-0.3861	0.2243	0.085	0.6797
Night	1.6930	0.5878	0.004	5.4359
Constant	7.7997	5.6396	0.167	
Variance and covariance of random intercepts:				
Level II (coyote): 0.2435 (0.6394)				

The plot below shows how rapidly the predicted probability of a fawn kill occurring declines throughout the summer. The plot differentiates the naïve estimate (solid black line) derived from a simple logistic model from the coyote-specific estimates (dashed lines) derived from the mixed effects formulation of the model reported here. From the plot you can see considerable variation among individuals in their overall kill rates based on their different y-intercepts. Filled black symbols denote males (2 of the 5 studied) and open symbols denote females (5 of the 10 studied).



We are in the process of validating this model (STEP 4) and applying it to the remaining cluster data to estimate fawn kill rates by individual coyote on a weekly basis throughout the summer (STEP 5). We intend to apply a similar process to modeling adult deer kill rates in winter, but focusing on identifying carcasses visited (instead of kills directly) of which we expect 5% of the carcasses to have actually been killed by coyotes (see previous progress reports for details on adult deer field data).

We anticipate our kill-rate analyses to be completed and a manuscript on this work prepared for journal submission by the end of the summer.

Estimating Coyote Population Size

We are employing two approaches to estimating the size of coyote populations in NY State. The first is a non-invasive genetic approach relying on: 1) intensive searches for scats at defined temporal intervals, 2) "fingerprinting" individual coyotes from those scats, and 3) conducting a genetic capture-mark-recapture analysis to estimate local population sizes. Scats have been collected in our two focal areas over a period of three years and will be used to provide both local density estimates (to link to our kill rate data) as well as insight into the temporal dynamics of coyote density, e.g, differences from summer to winter and among years. We acquired scat during summer 2010 from three additional areas to provide density estimates in different regions of the state also using this approach. We saved money by extracting the DNA from these scats ourselves and have sent the samples to Wildlife Genetics International to complete the multilocus genotyping. We expect the data to be back and ready for statistical analysis by fall 2011. This is a labor-intensive and expensive process that is necessarily constrained in terms of its spatio-temporal scope of inference, therefore we employed a second approach detailed below.

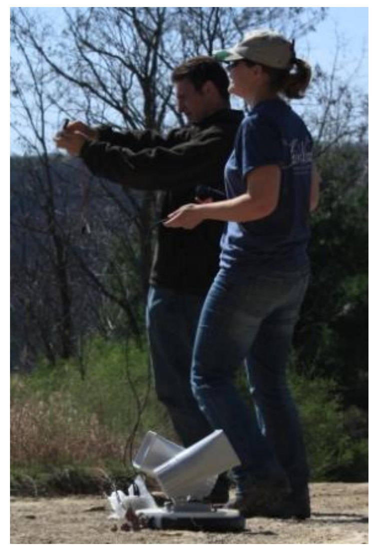
This past summer we sampled coyote populations statewide using call-response surveys linked to distance sampling and report herein on our baseline, statewide population estimate. This approach has a coarser resolution for density than the DNA-based approach (with ecoregions being the smallest definable sampling unit based on our survey effort), but the approach is efficient, road-based, and robust. We report on our progress for this second approach in the section to follow.

Statewide Population Estimate **(S. Hansen)**

In summer 2010, we implemented a novel approach to estimating coyote abundance that is less intensive than previous approaches (e.g., DNA mark-recapture estimates), circumvents property access limitations, and provides a reliable method for tracking changes in coyote populations over broad spatio-temporal scales. The approach paired road-based coyote call-response surveys with distance sampling protocols to estimate both the probability of coyote detection and regional abundance of coyotes.

Distance sampling assumes that detectability, but not density, degrades with distance from a survey point or transect and uses data on the number of detected individuals (or groups) at different distances to correct for animals missed during a survey (Buckland et al. 2001). In most cases, distance sampling techniques rely on passive observance of an animal or its sign. However, these approaches have been successfully applied to call-response surveys for otherwise elusive species (Conway and Gibbs 2005). Coyotes are social animals known to respond vocally to certain stimuli, which makes it possible to play a recorded call and elicit a response call from an animal within hearing distance (Alcorn 1946).

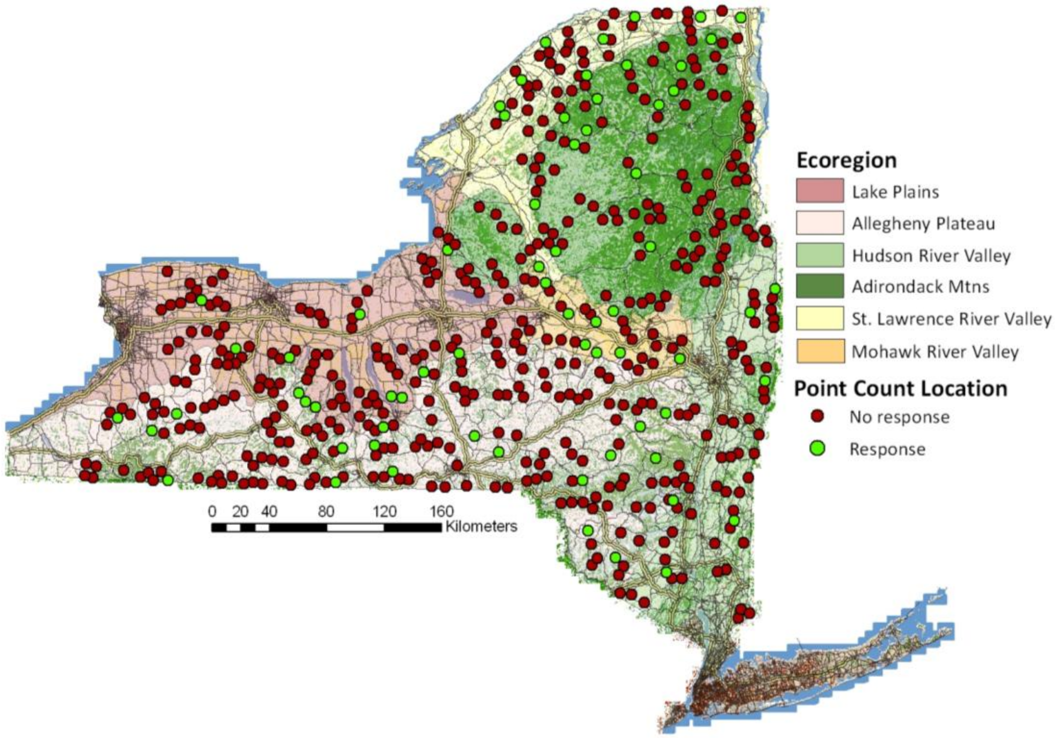
Vocalization surveys for coyotes have been used since at least the 1940s to provide an index of coyote abundance. The unique and difficult element of our study was the determination of distance between the observer and the responding coyote to estimate the probability of detecting a calling coyote and derive a formal estimate of coyote density with precision. We estimated distance by triangulation, placing 3 observers 500-m apart along the segment of road being surveyed. Recognizing that this may limit the utility of this approach for future surveys, we are investigating whether we can remove the distance-estimation requirement by modeling a static probability of detection as a function of local landscape and weather covariates that can be applied to correct raw coyote counts in future surveys.



MS student Sara Hansen and technician Nick Deuel conduct howling simulations to estimate distance to a calling coyote.

Our approach consisted of 3-person field crews, with 1 observer stationed at the "calling" point (with the call broadcast unit) and the other 2 stationed 500 m away in opposing directions. Recorded coyote calls were broadcast by the central observer in cycle of a 20-sec call followed by a 2-min listening period. The broadcast unit was placed on the road because field tests indicated this helped carry the sound farther than holding the unit up high or placing it on top of a vehicle. The call and 2-min listening period cycle was repeated 3 times, with each cycle louder than the previous. When a coyote response was detected, the call cycle was stopped, each observer took bearings on all responding coyotes, estimated distance based on call quality, and recorded the number of individuals heard with certainty. Individual coyotes can be reliably counted only as each individual coyote joins the group howl, within the very first few seconds of the response. Reliably, up to approximately 4 to 5 individuals can be detected using this approach. A 5-min listening period was added at the end of all responses to ensure all detectable responses were heard. Local weather conditions were recorded at time of survey and landscape attributes at each site were obtained from GIS layers.

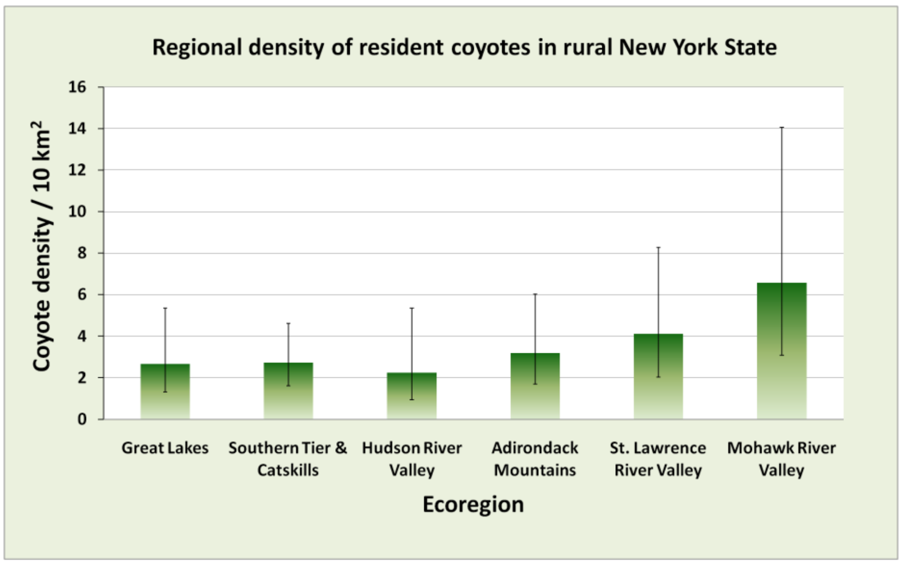
A total of 770 potential survey points were initially identified so as to avoid urban and heavily trafficked areas (interstates and main highways). Survey points were separated by at least 6 km to ensure independence on a single survey night (i.e., ensuring we do not survey the same coyote twice). For ease of implementing the survey, points were assigned to 5-point



"transects" (1 transect = 1/2 survey night) with approximately 10 to 15 km separation between each transect to provide greater independence across the survey season. Surveys were conducted between dusk and dawn on wind-free nights throughout the peak summer response period (late-June through late-August). Three crews stationed throughout the state conducted the surveys and ensured even spatio-temporal coverage.

A total of 541 points were successfully surveyed with 151 points eliminated due to close proximity of houses and excessive noise (see map above). Responses were observed at 89 points, and multiple responses at any given point resulted in 117 total responses. Coyotes were heard reliably out to about 1800 m. Using Program DISTANCE we estimated the probability of detecting a calling coyote to be 0.1985 (0.0268 SE). The second required probability required to correct our raw survey counts is the "response rate", or the probability that an individual coyote will respond vocally to our stimulus. To estimate the response rate, we conducted 32 call-response sessions using known (collared) animals during a winter pilot study, yielding a 34% response rate. Response rates vary somewhat seasonally, but similar values occur during winter and late summer. There are few reliable estimates of coyote response rates in the literature, and reported values range from 25-50%. Efforts to estimate response rates have focused exclusively on "territorial" individuals, and researchers presume that transient individuals are much less likely to respond. Thus, we presume our total population estimate to not be inclusive of transient individuals. Moreover, to derive total population size and density estimates we defined our study region as "rural" New York State, excluding areas mapped as urban or developed on the National Land Use Land Cover Database (NLCD).

Based on our estimated probability of detecting a calling coyote and an expected 35% response rate (average from the literature and our study), we estimate the total abundance of resident coyotes in rural New York to be 34,489 (95% CI: 18,026 – 66,674). Density estimates suggest a nearly homogenous distribution of coyotes across the state with some evidence of higher densities in the St. Lawrence and Mohawk River Valleys (see graph below and cross-reference to previous map). Our estimates of coyote density, ranging from roughly 2 animals / 10 km^2 in the Hudson River Valley to 6 coyotes / 10 km^2 in the Mohawk River Valley, are comparable with other estimates from the Northeastern US (Gompper 2002).



In evaluating whether road-based surveys might induce a bias into our estimates, we found no differences in the land use/land cover types occurring around our sample points (buffered by 1800 m) and random landscape points (buffered by 1800 m). Our GPS collared coyotes indicated avoidance of areas within 100 m of a road, but the resolution of our distance categories was 300 m, and given that our surveys extended to 1800 the localized road bias of coyotes was unlikely to have negatively affected our population estimate.

Controlled tests, using a call broadcasting unit played at known distances in different habitat types, have shown that moderate topographic variation, dense understory, and wind speeds greater than 5 kph lowered call detectability. We are currently evaluating whether we can remove the need to estimate distance during a survey by modeling the probability of detection as a function of landscape features and survey conditions in advance.

The statewide population survey will be written up for submission to the Journal of Wildlife Management this June, and analyses for modeling an independent probability of detection model will continue through this fall.

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Outreach

The following outreach efforts were made since May 2010.

Conference Presentations

The Wildlife Society Annual Conference – Snowbird, Utah (September 2010)

- "Use of GPS cluster to estimate coyote kill rates of white-tailed deer" (oral presentation). Holevinski, R., Frair, J.L., Batcheller, G.
- "Abundance estimation of Eastern coyote populations in New York State via vocalization surveys and distance sampling" (poster). Hansen, S., Frair, J.L., Underwood, B. and Batcheller, G.

The Northeast Fish and Wildlife Conference, Manchester, New Hampshire (April 2011)

- "Abundance estimation of coyote populations in New York State via vocalization surveys and distance sampling"(oral presentation) – Hansen, S., Gibbs, J.P., Underwood, B. and Frair, J.L.
- "Use of GPS cluster to estimate coyote kill rates of white-tailed deer" (oral presentation) – Holevinski, R., Frair, J. L., Batcheller, G.

Other Presentations

- SUNY ESF Cranberry Lake Biological Field Station (July 2010)
- Steuben County Fair (poster on coyote foraging ecology; August 2010)
- SUNY ESF Vertebrate Conservation Conversation Seminar Series, Syracuse, (Sept 2010)
- Fur Takers of America Trappers' College, South Milford, Indiana (September 2010)
- New York State Trappers Convention (poster on coyote foraging ecology; Sept 2010)
- Steuben County Rotary Sportsmen Dinner, Canisteo (October 2010)
- NYS Trappers Association and NYSDEC Youth Trappers Camp, Caneadea (October 2010)
- SUNY ESF Geographic Information Systems Day, Syracuse (October 2010)
- SUNY ESF Vertebrate Conservation Conversation Seminar Series, Syracuse (Feb 2011)
- Erie County Federation of Sportman's Clubs (February 2011)
- DEC Bureau of Wildlife Annual Meeting, Hamilton (March 2011)
- Victory Sportsmen Expo, Painted Post (March 2011)
- The Vertebrate Conservation Conversation Seminar Series, Syracuse (March 2011)
- New York Houndsmen Annual Meeting, Camden (March 2011)
- Tioga County and surrounding Sportsmen Federations, Owego (April 2011)
- New York State Trappers Association Annual Meeting, Delmar (April 2011)
- NYSDEC, Managers Meeting (April 2011)
- Affiliated Conservation Clubs of Madison County, Madison (May 2011)
- Camillus Middle School, Camillus (May 2011)

Interviews, Press Coverage, Popular Articles

- New York Hunting & Trapping 2010-11 Guide to Laws & Regulations
- The Outdoor Channel, Management Advantage "Trapping Chronicles" (September 2010)
- North Country Now, Craig Freilich (November 2010) "'Robust' population of coyotes in North Country may be part wolf"
- Adirondack Explorer (interviewed October 2010)
- Springville Journal, Forrest Fisher (stemmed from Erie County Sportsmen meeting in Feb 2011, not formally interviewed for this article) "Rod, Gun & Game: Coyote predation may affect deer population" (http://www.springvillejournal.com/sports/828-424-Coyote_predation_may_affect_deer_population.html)

- Buffalo news, Will Elliot (February 2011) "Presentation bursts dogged myths" (http://findarticles.com/p/news-articles/buffalo-news/mi_8030/is_20110227/presentation-bursts-dogged-myths/ai_n56967827/)
- State Wildlife Research News (April 2011) "Howl to survey coyotes" (not formally interviewed for this posting that stemmed from S. Hansen's presentation at the Northeast Fish and Wildlife Conference; http://wildliferesearchnews.blogspot.com/2011/04/howl-to-survey-coyotes.html#links)

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SUNY Cobleskill
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Appendix I. Capture details[1] and status of GPS- and VHF-collared coyotes in Otsego County from June 2007 – May 2011.

Animal ID #	Capture date	Sex	Age / status	Collar type	Trap type	Injuries/comments	Current status	Cause of death
M1	6/10/07	M	Adult	VHF	Foothold	No injuries	Dead 1/23/09	Trapped
M2	6/10/07	M	Adult	GPS	Foothold	Cut on foot	Dead 11/5/07	Shot by landowner
M3	6/11/07	M	Adult	VHF	Cable restraint	Swollen neck	Dead 2/15/08	Shot by landowner
F4	6/18/07	F	Adult	GPS	Cable restraint	No injuries	Dead 10/20/07	Shot by landowner
F5	6/21/07	F	Adult	GPS	Foothold	Cut on foot	Dead 1/24/09	Shot by houndsman
M6	6/22/07	M	Adult	GPS	Foothold	No injuries	Dead 11/18/07	Found dead, broadhead
M7	6/30/07	M	Yearling	VHF	Cable restraint	No injuries	Dead 11/2/09	Shot by predator hunter
F8	7/15/07	F	Sub-Adult	VHF	Cable restraint	Swollen neck	Dead 5/12/08	Found dead, mange
F9	7/25/07	F	Adult	VHF	Foothold	Cut on foot	Dead	Shot by deer hunter
F10	7/2707	F	Adult	VHF	Foothold	No injuries	VHF battery expired	
M11	8/15/07	M	Adult	VHF	Foothold	No injuries	Dead 6/01/08	Shot by landowner
F12	11/8/07	F	Adult	VHF	Foothold	Missing 2 toes	Dead 11/14/07	Shot by landowner
M13	11/18/07	M	Sub-Adult	VHF	Foothold	Cut on foot	Dead 11/20/08	Shot by landowner
F14	1/13/08	F	Adult	VHF	Foothold	No injuries	Missing	
F15	1/29/08	F	Yearling	VHF	Foothold	No injuries	Dead	Shot by houndsman
M16	4/10/08	M	Adult	GPS	Foothold	No injuries	Dead 1/8/09	Trapped in Pennsylvania
F17	4/17/08	F	Sub-Adult	VHF	Foothold	No injuries	Missing	
F18	4/17/08	F	Sub-Adult	VHF	Foothold	No injuries	Dead 6/18/09	Road kill
F19	4/18/08	F	Adult	GPS	Foothold	No injuries	Drop-off failed, no contact	
F20	4/19/08	F	Adult	GPS	Foothold	No injuries	Dead 1/14/09	Shot by houndsman
M21	4/22/08	M	Adult	GPS	Foothold	Toe bleeding	Dead 10/31/09	Shot by predator hunter
F22	4/25/08	F	Sub-Adult	VHF	Foothold	Cut on foot	Dead 1/13/09	Found dead, gunshot
F23	6/13/08	F	Sub-Adult	VHF	Foothold	Cut on foot	Missing	
M24	11/04/08	M	Sub-Adult	VHF	Foothold	Cut on toe	Missing	
F25	11/05/08	F	Sub-Adult	VHF	Foothold	No injuries	Missing	
F26	11/15/08	F	Adult	GPS	Foothold	No injuries	Dead 1/15/2010	Dead
F27	4/16/08	F	Yearling	VHF	Foothold	Cut on foot	Dead 2/8/10	Shot by predator hunter
F28	4/16/09	F	Sub-Adult	GPS	Foothold	Cut on foot	Dead 1/19/10	Shot by houndsman
F29	4/18/09	F	Sub-Adult	VHF	Foothold	No injuries	Missing	
M30	4/18/09	M	Adult	GPS	Foothold	No injuries	Drop-off failed, no contact	
M31	4/20/09	M	Adult	GPS	Foothold	No injuries	Drop-off failed, no contact	

[1] To protect the integrity of the study, capture locations and radio-collar frequencies will be kept confidential until the close of the study.

Appendix 2. Capture details[1] and status of GPS- and VHF-collared coyotes in Steuben County from June 2007 – May 2011.

Animal ID #	Capture date	Sex	Age / status	Collar type	Trap type	Injuries/comments	Current status	Cause of death
SF1	11/02/07	F	Adult	VHF	Foothold	Cut on foot	Missing	
SF2	11/05/07	F	Adult	VHF	Foothold	Cut on foot	VHF battery expired	
SF3	11/06/07	F	Sub-Adult	GPS	Foothold	Cut on back	GPS dropped off	
SF4	11/17/07	F	Adult	GPS	Foothold	No injuries	GPS dropped off	
SM5	12/30/07	M	Adult	GPS	Cable restraint	Swollen neck	Drop-off failed, no contact	
SM6	1/14/08	M	Sub-Adult	GPS	Foothold	No injuries	Dead 10/12/10	Shot by deer hunter
SF7	1/18/08	F	Sub-Adult	GPS	Cable restraint	No injuries	Dead 2/23/08	Found dead, gunshot
SF8	4/09/08	F	Adult	VHF	Foothold	Cut on foot	Dead 11/15/08	Shot by deer hunter
SF9	4/12/08	F	Adult	GPS	Foothold	Cut on foot	Drop-off failed, no contact	
SF10	4/12/08	F	Adult	GPS	Foothold	Cut on foot	Dead 12/6/09	Shot by deer hunter
SM11	4/24/08	M	Adult	VHF	Foothold	Abrasion on foot	Dead 11/6/08	Trapped
SM12	4/26/08	M	Adult	VHF	Cable restraint	Swollen neck	Missing	
SM13	6/12/08	M	Adult	VHF	Cable restraint	Swollen neck	Dead 6/19/10	Found dead, unknown
SF14	4/29/08	F	Adult	VHF	Foothold	Cut on foot	Missing	
SM15	5/07/09	M	Adult	VHF	Foothold	No injuries	Dead 10/25/10	Road kill
SF16	5/11/09	F	Adult	VHF	Foothold	Foot amputated	Dead 10/28/09	Shot by landowner
SF17	6/04/09	F	Sub-Adult	GPS	Cable restraint	Swollen neck	Dead 2/13/10	Shot by houndsman
SF18	6/28/09	F	Adult	GPS	Cable restraint	Swollen neck	Dead 12/28/2010	Trapped
SF19	12/19/09	F	Adult	VHF	Foothold	No injuries	Missing	

[1] To protect the integrity of the study, capture locations and radio-collar frequencies will be kept confidential until the close of the study.