Bobcat population ecology and viability in Ohio

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COLLABORATORS

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ODOW Wildlife Officers (Roadkill collection)

Suzanne Prange, AWRI
Christa Rose, Native Species Support

Bill Peterman, OSU
Kevin Shoemaker, U of Nevada
Stephen Spear, USGS
Genelle Uhrig, The Wilds

15+ undergraduate students
Volunteers and citizen scientists
Ohio University Wildlife Club
Ohio Wildlife Management Association
Up to 2012 – Two subpopulations that are genetically distinct from the surrounding States and distinct from each other to a limited extent

Anderson et al. 2015 in Canadian J of Zoology

Bobcats recolonizing Ohio since mid 1900’s

Bobcat verified sightings

>1500 by 2019 (including roadkill)
95% of sightings after 2000
80% of sightings after 2010
Solving the bobcat puzzle…

What is the population status and viability?

- Many sources of data
- Gathered at different spatial and temporal scales
- Systematic or non-systematic
- Missing pieces?

How to combine everything into a COHERENT and MANAGEMENT-RELEVANT story?
Solving the bobcat puzzle…

What is the population status and viability?

- Verified sightings
- Roadkill locations
- Necropsies of roadkills
- Telemetry data
- Camera trap data
- Density/abundance data
- Genetic data
- Demographic data

How to combine everything into a COHERENT and MANAGEMENT-RELEVANT story?
PROJECT OBJECTIVES

**Obj1.** Determine predictors of road mortality, and the overall risk of road mortality for the bobcat population

**Obj2.** Evaluate current occupied range, and predict future areas for expansion

**Obj3.** Identify population clusters to inform management

**Obj4.** Evaluate bobcat occupancy and density in two core area in S and SE Ohio

**Obj5.** Predict population trajectories and acceptable harvest limits levels using a Spatial Population Viability Analysis framework
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Bobcat camera trap and roadkill sightings in SE Ohio

2000 - 2019
Questions

What are predictors of roadkill and annual mortality risk from vehicle strikes
   – ROADKILL OCCURRENCE DATA

What is the risk posed by roadkill for different segments of the population
   – NECROPSIES OF ROADKILL ANIMALS
Roadkill risk was associated with:

- High traffic roads: Interstates Routes, US Routes, State Routes
- Higher road density
- Land cover type: Higher proportion of forest

Bencin et al. 2019
Probability of bobcat mortality from vehicle strikes

Route type
- Interstate Route
- State Route
- US Route

Probability of being killed on road
- 0.004920 - 0.200000
- 0.200001 - 0.400000
- 0.400001 - 0.600000
- 0.600001 - 0.800000
- 0.800001 - 0.999680

Bencin et al. 2019
Annual road mortality estimates

Annual mortality weighted by road types and road-crossing behavior

<table>
<thead>
<tr>
<th></th>
<th>Mean female (178 crossings)</th>
<th>Mean male (195 crossings)</th>
<th>Minimum (41 crossings)</th>
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A minimum of 6% of the bobcat population in Ohio could be lost to roads each year.
Roadkill carcass collection by Ohio DNR

2010-14 – 202 carcasses (Rose and Prange 2019)

2019-20 – 108 carcasses

- sex
- age (tooth cementum analysis)
- biometrics
- reproductive tracts
- diet
- genetic analyses
Roadkill carcass collection by Ohio DNR

2010-14 – 202 carcasses
78 females (39%)
124 males (61%)

2019-20 – 108 carcasses
44 females (40%)
62 males (60%)
Roadkill Analysis Summary

Roads pose a high risk to bobcat population – at least 6% of the population could die on roads.

Future increases in traffic may lead to higher roadkill rates.

Mitigation difficult → account for this source of mortality in management decisions.

Young, dispersing animals more likely to be killed on roads → evaluate how this impacts population viability.
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Bobcat verified sightings

Increases in reporting after 2010 (camera trap bias?)

>1500 by 2019 (including roadkill)

95% of sightings after 2000

80% of sightings after 2010
Bobcat habitat suitability and connectivity in Ohio

Questions
What is the habitat suitability (at population level) for the recovering bobcat population in Ohio?

Are there limitations to bobcat dispersal and movements in Ohio?

Bill Peterman
Ohio State Univ

Marissa Dyck
PhD student
Ohio Univ
Bobcat habitat suitability and connectivity in Ohio

Questions
What is the habitat suitability (at population level) for the recovering bobcat population in Ohio?
Are there limitations to bobcat dispersal and movements in Ohio?

• 1000+ “verified sightings” MINUS potential dispersing individuals
• 4x more “pseudo-absences” OUTSIDE the main area of occurrence
• Resource Selection Function

Popescu et al (in review) PeerJ
Bobcat habitat suitability in Ohio

**Question:**
What is the habitat suitability (at population level) for the recovering bobcat population in Ohio?

**Best predictors from binary (logistic regression):**
- Proportion of forest (at 50 km²)
- Proportion of pasture (at 50 km²)
- Proportion of herbaceous vegetation (at 30 km²)
- Distance to high traffic roads
Bobcat habitat suitability in Ohio

**Question:**
What is the habitat suitability (at population level) for the recovering bobcat population in Ohio?

**Findings:**
- High suitability in SE Ohio
- Ohio River Valley – important corridor (but also high roadkill!)
- NE Ohio moderate suitability, but connected to the PA population
- Central, W and NW Ohio – occasional sightings (dispersers?)
- Reflects CURRENT (to 2019) situation; update with new data if population still expanding
Bobcat habitat connectivity in Ohio

Questions:
- Are the S and E populations connected?
- Are there conduits for movement and dispersal between different regions of Ohio?

Findings:
- **Circuitscape analysis**
- No barrier to movement between the E [1] and S [2] populations
- Ohio River Valley: a very important movement corridor
- High connectivity to NE Ohio
- Riparian forest and river valley provide connectivity to W, NW and N Ohio
Habitat Analysis Summary

Flexible habitat selection, but occupies **predominantly forested areas** of OH

Areas of potential expansion still exist (SW and NE Ohio) and connectivity to the core population is high

S and E subpopulations – highly connected

Potential connectivity “pinch-point” in S Ohio along the Ohio River

Riparian areas and **forest patches** in interior OH act as conduits for dispersal
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Up to 2012 – Two subpopulations that are genetically distinct from the surrounding States and distinct from each other to a limited extent

Anderson et al. 2015 in Canadian J of Zoology

Questions:
Did the two subpopulations differentiate further or did they merge?

Should subpopulations be managed as distinct genetic / demographic units?
Genetics of roadkill bobcats

2019-20 — 108 carcasses
— 12 ear / toe pad samples

Will Heffern
MSc 2021
Ohio Univ

Stephen Spear
The Wilds
USGS

Genelle Uhrig
The Wilds
- Examine genetic differentiation based on 9 microsatellite loci
- Use program STRUCTURE and adegenet to calculate number of population clusters and assignment
Almost complete admixture $\rightarrow$ no distinct genetic population clusters

Difficult to identify best methods to characterize genetic makeup $\rightarrow$ typical for populations that have NOT yet reached equilibrium

High habitat connectivity facilitated admixture between S and E subpopulations $\rightarrow$ but important to facilitate dispersal and gene flow across OH and beyond
PROJECT OBJECTIVES

**Obj1.** Determine predictors of road mortality, and the overall risk of road mortality for the bobcat population

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Camera trapping 2018 in SE Ohio

- 57 cameras
- 228 hair snares

Heidi Bencin, MSc 2019
DNA collection - rubbing
KITTENS GALORE
The Secret Lives of Bobcats
The Secret Lives of Bobcats
Multi-method occupancy

Probability of bobcat occupancy = 0.40 (95% CI = 0.290 – 0.533)

Probability of detection for:
Camera traps = 0.231 (95% CI = 0.203 - 0.263)
Hair snares = 0.100 (95% CI = 0.081 - 0.123)
Bobcat and coyote co-occurrence

Coyote occurrence = 0.95
Bobcat occurrence = 0.40

- There may be some avoidance (temporally)
- Likely partition core habitat

Number of photos per camera

When carnivores collide: a review of studies exploring the competitive interactions between bobcats *Lynx rufus* and coyotes *Canis latrans*

Marissa A. Dyck, Eileen Wyza, Viorel D. Popescu

First published: 01 July 2021 | [https://doi.org/10.1111/mam.12260](https://doi.org/10.1111/mam.12260)
Bobcat population abundance/density

- Toughest question in wildlife ecology and management
  - Often unanswered

- Extremely difficult to estimate for elusive animals

- Current methods: environmental DNA
  → poop science
Scat surveys on 58 transects (501 km) ~250 km² coverage
Repeated 3 times between June 2018 - April 2019
792 scats collected
360 scats ID’d as bobcat
Bobcat population abundance/density

Progress

- 133 samples (37%) amplified with consensus at 1+ microsatellite loci

- PENDING: minimum number of individuals (47 different individuals identified thus far)

- NEXT: spatial capture-recapture analyses (many individuals with 3 “recaptures”)
Occupancy and Density Summary

Camera trapping with lure → great for monitoring bobcats (and other carnivores!)

No “full” occupancy → habitat use influenced by landscape but also coyotes

Density estimates difficult to obtain, even for small areas → prelim data indicate local densities of ~20 animals / 100 km²

Q: are density estimates critical for management decisions?
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Understand the population status and trajectory in Ohio

- Verified sightings
- Roadkill locations
- Necropsies of roadkill animals (necropsy)
- Telemetry data
- Camera trap data
- Density/abundance
- Genetic makeup

How to combine them into a coherent story of Bobcat ecology and management?
Population Viability Analysis (PVA)

Address main sources of mortality
- **Current**: roadkill
- **Potential**: harvesting
  1. Harvest all ages
  2. Harvest adults only (ages 2+)

**Questions**
Are roadkill and harvest mortality ADDITIVE or COMPENSATORY?
What are sustainable harvest limits?

PVA: not the definitive answer to a management question, but a tool that explores management outcomes: **INTUITION UPDATE**
Bobcat Population Model

- **Stochastic population model** (female and male) with demographic stochasticity only

- **Density-dependent ‘ceiling’** (no assumptions that DD acts differently on fecundity or survival) based on Habitat Suitability

- Includes **dispersal** for age 1

- Additional road mortality based on observed frequencies for males and females
Bobcat Population Model

Stage-based matrices for UNHARVESTED POPULATIONS
(existing literature, supplemented with Ohio fecundity and mortality data)

“LOW” vital rates population matrix

<table>
<thead>
<tr>
<th>STAGE</th>
<th>0</th>
<th>1</th>
<th>2-4</th>
<th>5+</th>
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$\lambda = 1.062$

“HIGH” vital rates population matrix

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$\lambda = 1.398$

Stable-Stage Distributions
(proportions of population by age class for populations at equilibrium)
Bobcat Population Model

Model runs
- 300 simulations for 40 years
- “Baseline” model runs without additional harvest or increased roadkill

λ = 1.062  “LOW” vital rates

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λ = 1.398  “HIGH” vital rates

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Observed roadkill does not match the Stable Stage Distribution

1-year old female bobcats are being hit on the road at a rate TWICE that of the proportion of 1-year old females in a population at equilibrium.
Bobcat Population Model

Scenarios

Population segment harvest
- ALL AGES
- ADULTS (age 2+)

Harvest limit
- 3%
- 5%
- 7%
- 10%

Max. density assumption
- 30 indiv / 100 km²

Additional roadkill
- YES
- NO
Bobcat Population Model

Harvest pressure → probability that an individual would be trapped = 0.05

Findings
• More opportunity for harvest if focus on ALL AGES
• Less variability in future projections for ALL AGES
Bobcat Population Model

Harvest pressure $\rightarrow$ probability that an individual would be trapped = 0.05

+ additional roadkill

Findings

- Additional roadkill increases number of declining projections
- Introduces variability in harvest opportunity
- ALL AGES still less variable
Bobcat Population Model

Harvest pressure $\rightarrow$ probability that an individual would be trapped = 0.03, 0.05, 0.07, 0.10

**ADULTS-ONLY**

**ALL AGES**

**Findings:** Increasing harvest pressure results in more variable populations and lower harvest opportunity when harvesting ADULTS ONLY.
Population Model Summary

Harvest and roadkill: additive or compensatory? → Additive for ADULTS-ONLY, and compensatory to some extent for ALL AGES

Harvesting ADULTS ONLY → more sensitive, lower harvest opportunity, higher risk of declining populations

Harvest limits → 3-5% of the population sustainable, especially if focusing an ALL AGES

Additional roadkill makes the population more prone to crashing, especially at higher harvest limits

Model less sensitive to maximum abundance assumptions → max densities similar to Virginia (20 adults + 10 young / 100 km²) can maintain sustainable harvest levels
SUMMARY

Bobcat population still expanding – single population with mixed genetic makeup

Flexible habitat requirements, but intensive agriculture limits expansion (similar case in IA, IL, IN)

Road mortality – significant and affects harvest opportunity

Density/abundance – costly and time intensive; monitor other relative indicators of population status (roadkill!)

Bobcat population status – increasing, viable → sustainable management

Limited harvest → likely sustainable; lower limits early on to understand which population segments are being trapped

Importance of long-term data collection, research and monitoring!!!