OHIO BOBCAT MANAGEMENT PLAN

Ohio Division of Wildlife, Columbus, OH
September 2023

Acknowledgements – The Ohio Division of Wildlife is grateful to staff of The Wilds, Ohio Division of Natural Areas and Preserves, Ohio Division of Forestry, and Wayne National Forest for access to study sites. We further thank the individuals who conducted research projects to collect information on Ohio's bobcat population, with special thanks to Dr. Suzanne Prange, Dr. Christine Anderson and Dr. Lisle Gibbs for bobcat genetic analyses, Dr. Viorel Popescu, Marissa Dyck, Heidi Bencin, and Will Heffern for their work on the Ohio University bobcat research project, and Christa Rose of Native Species Support, Cheryl Mollohan, and Al LeCount for conducting bobcat field research.

Recommended Citation: 2023. Ohio Bobcat Management Plan. Ohio Department of Natural Resources Division of Wildlife. Columbus, OH.

Executive Summary

The bobcat (*Lynx rufus*) is the most widely distributed native felid in North America with recent self-repatriation in Ohio and other Midwestern states (Roberts and Crimmins 2010). In Ohio, bobcats were extirpated from the state by the mid-1800s but began to naturally recolonize in the mid-1900s. A combination of monitoring and research has revealed that Ohio now supports an established bobcat population in the eastern and southern parts of the state, and the population is continuing to expand into other areas of suitable habitat (Popescu et al. 2021). The number of confirmed bobcat sightings reported annually began to steadily increase in the early 2000s. From 1970 to 2021, 4,159 confirmed sightings were documented in 81 Ohio counties.

Research conducted in Ohio has led to a greater understanding of the habits and resource needs of this re-established population. Genetic research conducted on samples collected in the early 2000s indicated that bobcats in Ohio were separated into two subpopulations with bobcats in eastern Ohio (Noble County and surrounding areas) genetically distinct from those in southern Ohio (Vinton County and surrounding areas; Anderson et al. 2015). More recent research showed evidence of increased admixture indicating that the two subpopulations are converging (Heffern 2021). The average home range size for GPS collared bobcats in Ohio ranged from 14.1 km^2 to 99.7 km^2 (5.4 mi^2 to 38.5 mi^2) (Prange and Rose 2020). Home range sizes were larger in southern Ohio than in eastern Ohio, indicating that eastern Ohio may provide higher densities of prey and/or better habitat conditions (Prange and Rose 2020). Similarly, density estimates in eastern Ohio (17.9 ± 4.3 bobcats per 100 km^2; 46.4 ± 11.2 bobcats per 100 mi^2) were higher than density estimates in southern Ohio (11.3 ± 2.9 bobcats per 100 km^2; 29.3 ± 7.5 bobcats per 100 mi^2) (Dyck et al., in review).

Bobcats monitored in Ohio were generally healthy. Average annual survival was 0.686 (95% CI 0.485–0.971). Roadkill was the most common source of mortality for collared bobcats. An estimated 6 to 18% of the bobcat population in Ohio is predicted to be killed on roads annually (Bencin et al. 2019). Investigation of the stomach contents of roadkill bobcats revealed that bobcats in Ohio consume a wide variety of prey. Eastern cottontail, white-tailed deer, and small mammals were particularly important components of bobcat diets (Rose and Prange 2015). Bobcats showed selection for forest habitat, natural herbaceous vegetation habitat, and areas with low road density (Popescu et al. 2021). Habitat suitability and connectivity models were developed using the locations of confirmed sightings. Bobcat habitat suitability is highest in southeast and southern Ohio, and moderately suitable habitat is available in northeast and southwest Ohio, with high connectivity to the well-established populations in southeast and southern Ohio (Popescu et al. 2021). Occasional bobcat sightings were recorded in areas predicted to have low habitat suitability and medium-low connectivity, suggesting that dispersal occurs throughout Ohio, including along riparian corridors in high-intensity agricultural areas.

Effective bobcat management in Ohio requires continued monitoring of populations using methods such as documenting sightings, roadkill, and collecting information through the annual bowhunter survey. Population viability modeling indicates that limited harvest opportunities could be implemented in Ohio without negatively affecting the long-term viability of the Ohio bobcat population (Dyck et al. 2023). However, multiple factors, including increasing impacts from roadkill, maximum density, and the age and sex distribution of harvested bobcats, have the potential to impact the population trajectory. Therefore, if a season is implemented, it is recommended that conservative harvest limits are used and additional monitoring,

including mandatory carcass collection, is employed to assess the impact of harvest. Because bobcat populations occur at varying densities throughout Ohio and the population is not yet at equilibrium, unit-based management recommendations will be needed to address state-wide population objectives.

This management plan establishes bobcat management zones based on information available from monitoring and research. The plan also identifies a management goal of sustaining the Ohio bobcat population at ecologically sound and socially acceptable levels and provides specific objectives and strategies to achieve this goal.

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I. Bobcat Biology and Life History

This section provides a brief overview of bobcat biology and life history based on the results of published research from across their range. More detailed reviews are available from Anderson and Lovallo (2003), Rolley (1987), and McCord and Cardoza (1982), among others.

Distribution

The bobcat (*Lynx rufus*) is the most widely distributed native felid in North America (Anderson and Lovallo 2003). Bobcats occur primarily in the United States, but their range extends north into Canada and south into Mexico. Historically, bobcats ranged throughout the contiguous United States, however they were extirpated from parts of the Midwest and portions of the mid-Atlantic region when they were displaced by intensive agriculture and urbanization, respectively (Nowell and Jackson 1996, Sunquist and Sunquist 2002). By the late 1990s, bobcats had started to make a comeback and were reported to be present in all continental U.S. States, except for Delaware; although their distribution was still restricted in several states in the Midwest and Eastern U.S. They remained protected in several states including Ohio, Indiana, Illinois, Iowa, and Pennsylvania, among others (Woolf and Hubert 1998). Since then, bobcats have increased in number and continued to expand their range (Roberts and Crimmins 2010). Some of the previously unoccupied habitat in the upper Midwest has been repopulated.

Description

The bobcat is distinguished from other felids by a short, bobbed tail that has a dark band on the upper surface only, in contrast to the completely banded tail tip of the Canada lynx (*Lynx canadensis*). They possess tufted ears and a facial ruff. Bobcat feet are digitigrade with sharp, retractile claws. The hind feet have four toes, and the front feet are larger than the hind feet and have a fifth raised toe (McCord and Cardoza 1982). In addition to its partially banded tail tip, the bobcat differs from the lynx in the lack of furred pads, longer tail, shorter ear tufts, and better-defined spots.

The upper pelage is yellowish to reddish having numerous black spots, with the degree of spotting varying by individual. In general, the color is darker along the midline of the back. Bobcats molt twice a year (McCord and Cardoza 1982). Pelage color varies geographically. In Ohio, as in some other areas, bobcats tend to be reddish during the summer and grayish during the winter. The belly is white with black spots and horizontal black bars or spots occur on the insides of the legs (McCord and Cardoza 1982). Large white spots occur on the backs of their ears. Both melanism and albinism have been reported. Melanistic bobcats have been reported from Florida (Ulmer 1941, Young 1958, Regan and Maehr 1990). Partial albinism, restricted to the forefeet was reported from Washington (Schantz 1939). Bobcat pelts reach maximum primeness (the time period when the fur is at peak color, density, and length, and therefore most valuable) during January and February (Stains 1979).

Males are generally larger than females, and adult bobcat weights vary considerably throughout their range. In Minnesota, adult males averaged 28.6 pounds and adult females 20.2 pounds during winter (Berg 1979), whereas in Oklahoma, males averaged 19.6 pounds and females 12.7 pounds (Rolley 1983). Bobcat body size thus appeared to follow Bergmann’s rule, which states that size increases with latitude and elevation (Sikes and Kennedy 1992). However, Wigginton and Dobson (1999) examined 950 bobcat skulls and concluded that bobcat size varied with food supply and seasonal energy demands rather than by following Bergman's Rule. In Ohio, male bobcats averaged 23.1 pounds, whereas females averaged 15.6 pounds. The largest male recorded in Ohio was 36 pounds (S. Prange, unpublished data).

Reproduction

Bobcats breed annually, with females generally coming into estrus in winter or early spring (December to April; Rolley 1987), although litters have been reported in every month (Duke 1954, Young 1958, Gashwiler et al. 1961, Fritts 1973, Crowe 1975a). Timing of breeding varies based on climate, region, age structure, and nutritional condition of the population (McCord and Cardoza 1982). The gestation period ranges from 63 to 70 days (Mehrer 1975), with most births occurring from late April through June. In Ohio, bobcats appear to reproduce year-round; however, the major birth pulse occurs in early to mid-May (S. Prange, unpublished data). Females generally have one litter per year; however, they will come into estrus additional times if they are not successfully bred during their first cycle or if a litter is lost (Winegarner and Winegarner 1982, Beeler 1985, Stys and Leopold 1993).

Females are capable of reproduction as early as nine months, but this rarely occurs (Crowe 1975a, Rolley 1985), while males are generally not sexually active until their second winter (Crowe 1975a). Pregnancy rates and litter sizes for yearlings are lower than those of adult bobcats and reproductive rates for adult bobcats may vary considerably based on prey availability and density of the bobcat population (Rolley 1985, Anderson and Lovallo 2003, Hansen 2007). Across their range, the average litter size for bobcats was 2.7 kittens (Anderson 1987) though litters of up to 6 kittens have been documented (Gashwiler et al. 1961, Parker and Smith 1983). Mean bobcat fecundity as evidenced by in-utero young and placental scars observed in bobcats in eastern Ohio was 0.4 for yearlings, and 3.0 for adults aged two to four years (Rose et al. 2020).

For the first month of life, kittens are cared for by the female in the den. Males are not involved in rearing the young. Den sites vary, but are often found in brush piles, hollow logs, caves, and rock shelters (Bailey 1974, Hamilton 1982, Kitchings and Story 1984, Lovallo 2007). In Ohio, the majority of natal dens observed by researchers occurred in extensive log piles created beside log landings of timber harvest operations, but natal dens were also located in burrows, tree cavities, and hollow logs (C. Mollohan and S. Prange, unpublished data). Females may move den sites frequently, particularly if the sites are disturbed (Bailey 1979, Wassmer et al. 1988, Hansen 2007). Kittens are weaned by 7–8 weeks after birth and start to accompany their mother on excursions away from the den around three months old (Young 1978, Bailey 1979). Young bobcats separate from their mother before the next breeding season (at 6–10 months old), and disperse from their natal range or remain nearby, but establish their own independent home range (Crowe 1975a, Kitchings and Story 1984, Anderson and Lovallo 2003). Dispersal distances vary but male bobcats usually disperse earlier and travel longer distances than females (Robinson and Grand 1958, Griffith et al. 1980, Bailey 1981, Hamilton 1982, Kitchings and Story 1984, Knick and Bailey 1986).

Mortality

Range-wide, most bobcat mortality is human related, specifically, vehicle collisions or harvest (where permitted). Annual adult survival for bobcats in harvested populations generally ranges from 56–67% (Anderson and Lovallo 2003). Unharvested populations usually have higher survival, with documented annual survival greater than 80% (Crowe 1975b, Chamberlain et al. 1999, Nielsen and Woolf 2002). Natural causes of adult mortality include disease, starvation, and predation but these generally account for a small percentage of bobcat deaths (Rolley 1987, Anderson and Lovallo 2003). Harvest mortality appears to be largely additive; however, with lower adult survival rates, pregnancy rates increase and the number of yearlings entering the population increases, meaning this may not have an impact on the population size overall (Anderson and Lovallo 2003). However, Knick (1990) found that harvest rates exceeding 20% led to population declines for bobcats in southeastern Idaho, and population viability models for Ohio's population indicated that harvest rates exceeding 5% could lead to population declines (Dyck et al. 2023). Kitten survival rates are considerably lower with average annual survival reported between 26–33% (Crowe 1975b, Blankenship and Swank 1979, Hoppe 1979). Kitten survival rates can vary considerably from year to year, with kittens particularly susceptible to starvation during years of low prey abundance (Bailey 1974, Knick 1990).

Habitat

Bobcats are adaptable to a wide range of ecosystems, if there is adequate prey and cover available. Throughout their range, bobcats are found in conifer and hardwood forests, deserts, swamps, and brushy fields. Cover provided by dense ground vegetation or topography (rock walls, etc.) is important for bobcats to be able to effectively hunt and can also provide protected resting and den sites (Hall and Newsome 1976, Miller 1980, Hamilton 1982). Prey availability appears to be a driving factor in habitat selection for bobcats, and high densities of prey will dictate habitat use. This appears to be particularly true for females, which maintain smaller home ranges, and require greater amounts of prey during kitten rearing (Bailey 1981). In contrast, males may use a greater variety of habitats (Lovallo 1999). Bobcats do make use of human altered landscapes in rural, suburban, and urban areas, but they avoid areas of intense agriculture, highly developed areas, or areas with a large amount of human activity (Rolley 1987, Nielsen and Woolf 2001a, Riley 2001, Anderson and Lovallo 2003, Popescu et al. 2021).

Food Habits

Bobcats are a generalist carnivore, whose diet consists of a variety of prey including rabbits and hares, rodents, mesocarnivores, deer, and less commonly, birds, reptiles, insects, and eggs (Rolley 1987, Anderson and Lovallo 2003). Throughout their range, diet varies based on age and sex of the bobcat, as well as prey availability in the region; however, lagomorphs (cottontails, snowshoe hares, and jackrabbits) often make up the majority of bobcat diet (Dearborn 1932, Bailey 1979, Parker and Smith 1983, Rolley 1987, Anderson and Lovallo 2003). White-tailed deer are an important diet component for bobcats in the northern portion of their range, particularly during the winter when they may be more susceptible to predation, or available as carrion (Dearborn 1932, Rollings 1945, Pollack 1951, Erickson 1955, Anderson and Lovallo 2003). Rodents are also important to bobcat diet, and depending on the region may include squirrels, woodrats, mice, and voles (Anderson and Lovallo 2003). Bobcats are stalk and ambush predators that rely on cover to stalk or wait for their prey to approach. Smaller prey may be consumed where it was killed (Hamilton 1982), while larger prey may be cached and consumed over a period of time (McCord and Cardoza 1982).

Home Range and Density

Bobcats are solitary, and interactions between bobcats are mostly limited to breeding, and females accompanied by dependent young. Adult bobcats establish home ranges, and show strong site fidelity (Bailey

1974, Litvaitis et al. 1987), but may shift their range if an adult with an adjacent range dies (Bailey 1974, Miller and Speake 1979, Hamilton 1982, Anderson 1988). There is great variability in bobcat home range from about 1 km^2 to greater than 300 km^2 (McCord and Cardoza 1982, Fox 1990, Hansen 2007). Female home ranges are generally smaller, and home range size for females is thought to be driven by the resource (prey and cover) availability (Anderson and Lovallo 2003). Female home ranges also tend to be more exclusive, with little to no overlap with other adult female ranges (Bailey 1974, Lembeck and Gould 1979), particularly within the core of their home range (Nielsen and Woolf 2001b). Male home ranges are generally at least 2–3 times larger than females in the area (Hansen 2007), overlap several female home ranges, and potentially other resident males (Bailey 1974, Berg 1979, Lovallo and Anderson 1996). Reported bobcat densities range from 4–27 bobcats per 100 km^2 (McCord and Cardoza 1982). Estimated bobcat densities in Ohio in 2018-2019 ranged from 11.3 ± 2.9 bobcats per 100 km^2 in southern Ohio to 17.9 ± 4.3 bobcats per 100 km^2 in eastern Ohio (Dyck et al., in review).

II. Bobcat Status and Management

Ohio Bobcat History and Current Status

The teeth and bones of bobcats have been found in prehistoric archeological sites in Ohio and were used to make implements and ornaments (Mills 1916). Bobcats were also depicted on Hopewell effigy pipes found in Ohio (Mills 1916; Figure 1). They have been mentioned in the diaries of many early Ohio residents, and prior to European settlement, occurred throughout the state but were most common in the lowland areas of northern Ohio, and the unglaciated southeastern portion of the state (Ohio History Central 2023).

Figure 1. Illustration of a bobcat effigy pipe found in Ohio (Squier and Davis 1848).

Ohio's forests have undergone dramatic changes since the late 1700s (pre-settlement), when nearly 95% of Ohio was forested. Rapid settlement of Ohio resulted in a steady decline of forest cover to a low of 12% in 1940. This massive loss of forest habitat was instrumental in the extirpation of many animals from Ohio including the bobcat, which was extirpated from Ohio by 1850. The bobcat was also overharvested and faced the general persecution of medium to large predators, being killed because of fear for personal safety, protection of livestock, and perceived competition for prey species. Ohio's forests began to increase in the 1940s and as of 2011 comprised approximately 33% of the state's land area (Widmann et al. 2014). This represents a 2.5-fold increase over 61 years and has been the major factor leading to the successful self-repatriation of many forest-dependent species, including the bobcat.

The first modern-day record of a bobcat in Ohio was in 1946, and occasional sightings were reported over the next 50 years, primarily in eastern and southern Ohio. In response to these occasional sightings, bobcats were listed as endangered when Ohio’s state list of endangered and threatened species was established in 1974. In the early 2000s, the number of confirmed sightings of bobcats collected annually started to steadily increase, and the distribution of confirmed sightings expanded. Based on the consistent growth in the number and distribution of sightings observed over the previous decade, bobcats were downlisted to threatened in 2012. Bobcats were then removed from Ohio’s list of endangered and threatened species in 2014 based on the results of research, monitoring, and evidence of established bobcat populations in southeastern and southern Ohio (See Appendix 1: Bobcat Downlisting and Delisting Documentation). A 2016 survey of Ohioans found that a majority of respondents (58%) had positive feelings towards bobcats, and 20% of respondents were supportive of regulated public trapping of bobcats, while 46% were opposed (Slagle et al. 2019).

Bobcats are classified as a furbearing animal in Ohio under Ohio Revised Code Section 1531.01 and Ohio Administrative Code Rule 1501:31-1-02. Harvest is not currently permitted, and removal of bobcats causing conflicts is only authorized with a permit issued by the Ohio Division of Wildlife Chief, or their designee.

Bobcat Status and Management in the US

Bobcats are known to occur in 47 U.S. states, 39 of which allowed regulated harvest as of the 2019-–2020 harvest season. A survey of wildlife agencies within bobcat range conducted by the Association of Fish and Wildlife Agencies in 2020 found that the bobcat population trend was increasing in 17 states, stable in 29 states, and unknown in one state (United States Fish and Wildlife Service 2021). Herein, we focus on the status and management of bobcats in states surrounding Ohio and other midwestern states.

In the states surrounding Ohio and the greater Midwest, bobcat harvest occurs in all but one state, Indiana (Table 1). Bobcat harvest is highly regulated and limited in the remainder of the states. Kentucky, with its relatively large bobcat population allows trapping and hunting statewide with a season bag limit of five, of which no more than three can be taken by gun. West Virginia is also open to bobcat harvest statewide, with a season bag limit of three, despite the fact that bobcat occurrence in the border counties with Ohio is rare (L. Palmer, personal communication April 2016). Michigan allows bobcat harvest in counties in the northern and central portion of the Lower Peninsula and all of the Upper Peninsula. The season bag limit for bobcats in Michigan is two per resident, but the second bobcat must be harvested on private land in the Upper Peninsula. Pennsylvania also limits the take of bobcats to certain Wildlife Management Units with a bag limit of one. All of these states have limited season dates for bobcat harvest, various permitting/license requirements, and all require that harvested bobcat pelts/carcasses are tagged (with a kill tag and/or CITES tag) and registered with the state agency, although the tagging and registration process differs by state.

As discussed in Chapter I, unharvested bobcat populations have high adult survival rates, and in harvested populations most mortality is largely attributable to harvest. Harvest mortality can impact the age structure of the population and high harvest rates can lead to population declines. As such, it is imperative to monitor population trends, as well as understand the response of bobcat populations to harvest. Roberts and Crimmins (2010) surveyed the 48 contiguous states regarding population status, distribution, and monitoring protocols for bobcats. Population models, bowhunter surveys, hunter surveys, harvest data, field studies, scent-post surveys, sign-station surveys, public sightings, and detection dogs are all techniques used in North America to monitor bobcat populations (Bluett et al. 2001, Anderson and Lovallo 2003). The majority of jurisdictions reported using multiple methods to monitor their bobcat population (Table 1).

One of the most commonly used survey protocols to monitor bobcat population trends is bobcat sightings, including the use of questionnaires (Anderson and Lovallo 2003). Ohio, Indiana, and Pennsylvania employ public sighting indices. Questionnaires can also be sent to hunters and trappers to collect information on bobcat observations (Woolf et al. 2000). For example, the number of bobcat sightings reported by archery deer hunters is commonly used to calculate an index of bobcat abundance (Anderson and Lovallo 2003). Ohio uses a bowhunter survey to monitor several other furbearer species, and this could become a primary tool for monitoring bobcat populations in Ohio in the future as their numbers continue to increase (See Chapter III, "Annual Monitoring" section, for additional information).

Table 1. Bobcat harvest status, population trend (modified from United States Fish and Wildlife Service 2021) monitoring methods, and population estimate (modified from Roberts and Crimmins 2010) for states surrounding Ohio and other Midwestern states.

State	Current Status	Population Trend (2009 -2019)	Monitoring (as of 2008)[a]	Population Estimate (as of 2008)
Indiana	Closed Season	Increasing	PS, IH	Unknown
Kentucky	Regulated Season	Increasing	HA	14,000
Michigan	Regulated Season	Stable	HS, SS	Unknown
Pennsylvania	Regulated Season	Increasing	HA, VC, IH, PS, PM	18,766
West Virginia	Regulated Season	Stable	HA	8,743
Illinois	Regulated Season	Increasing	HS	2,252
Iowa	Regulated Season	Increasing	PM, OT	1,155–2,331
Kansas	Regulated Season	Stable	HA, HS, SS	29,666–31,785
Minnesota	Regulated Season	Stable	HA, PM, SS, TS	2,857
Missouri	Regulated Season	Stable	HA, HS, SS	18,000–20,000
Nebraska	Regulated Season	Stable	NR	Unknown
North Dakota	Regulated Season	Stable	HA	Unknown
Oklahoma	Regulated Season	Stable	HA	Unknown
South Dakota	Regulated Season	Stable	HA, PM	Unknown
Wisconsin	Regulated Season	Increasing	HA, HS, PM, TS	2,850

a. PS = public sightings; HA = harvest analysis; HS = hunter surveys; PM = population model; SS = scent or sign station; TS = snow track surveys; IH = incidental harvest; VC = vehicle collisions; OT = other.

Surveys based on harvest data may also be used to monitor bobcat population trends. Annual harvest estimates could be used to assess population trends only if harvest pressure is relatively constant. This condition is unlikely to be met in bobcat harvest because harvest is often directly related to pelt prices (Rolley 1987). Harvest per unit of effort is considered more accurate to monitor population trends than total harvest but quantifying trapping or hunting effort may be difficult, as bobcats are often taken incidentally to other species (Rolley 1987). Nevertheless, this method (harvest analysis) is employed by most of the states (67%) listed in Table 1 and provides valuable information on bobcat populations. Careful monitoring of harvest, including mandatory harvest registration and surveys to assess harvest effort, would be essential if a harvest season is implemented in Ohio.

Patterns of age distribution may also be used to monitor population trends but are most useful when reproduction and survival rates are also known (Caughley 1977). These data can be obtained from harvested animals through mandatory carcass submission, a requirement in many states. However, when harvested animals are not available, roadkill bobcats become the primary source for age structure, sex ratio, and reproductive parameters.

Snow track surveys and scent station surveys are commonly used indirect methods to estimate relative abundance of bobcats. Snow track surveys use counts of bobcat tracks observed in snow along established transects as an index of abundance (Dhuey 2008). However, in Ohio, snow is too infrequent and unpredictable for snow tracking to be a viable monitoring method. The scent-station survey is one of the most common sign surveys used for indexing carnivore abundance in North America (Gese 2001). This survey also uses counts of bobcat tracks along a transect to produce a population index (Diefenbach et al. 1994). However, instead of relying on snow, plots of sifted dirt with an attractant placed at the center are used to detect tracks (Conner et al. 1983, Sargeant et al. 1998). While traditional scent station surveys rely on the detection of tracks, scent surveys that use remote cameras to observe activity at each station can be more efficient and less biased than traditional track surveys. Declining remote camera costs have made this a more viable option in recent years.

Examples of using remote cameras to assess long-term bobcat trends are currently limited. However, remote cameras have been used to collect other valuable information on bobcat populations throughout their range including occupancy rates, distribution, habitat preferences, and species interactions (Reed et al. 2017, Flores-Morales et al. 2019, Lombardi et al. 2020). For example, in Ohio an evaluation of camera trap data from Wayne National Forest and Zaleski State Forest in 2016 found an occupancy probability of 0.510 ± 0.045 for bobcats on the study area, and bobcat occupancy probability was negatively impacted by the presence of coyotes at a site (Rich et al. 2018). Additionally, the distinct markings of bobcats allow for identification of individuals from photographs, allowing for remote camera arrays to be used to estimate bobcat abundance (Heilbrun et al. 2006, Larrucea et al. 2007, Jacques et al. 2019). Remote cameras are valuable for collecting information on cryptic species and are a potential tool that could be used for future monitoring of Ohio’s bobcat population.

Established trends in population size and distribution are vital to monitor bobcat populations that are subject to harvest or at risk from other external factors. Furthermore, population models can be instrumental in the proper establishment and evaluation of areas open to harvest, bag limits, and seasons. Population models take into account not only known population parameters, but also stochastic variation that can have profound effects on harvest of a K-selected species (i.e., a species with a relatively slow recovery rate). Many states employ population models to monitor bobcat populations, predict changes, and regulate harvest. A Spatial Population Viability Model for Ohio’s bobcats was created by researchers at Ohio University (see Dyck et al. 2023, and Chapter III of this document). This model provides a tool for assessing the potential impact of various management scenarios on the Ohio bobcat population.

Furthermore, because Ohio’s bobcat population is still in the process of expanding, vital parameters will not remain static. Anderson et al. (2015) recommend that population structure should be assessed on a regular basis in this landscape until bobcats expand farther into unoccupied habitat, the eastern population is no longer spatially or genetically distinguishable, and the need to define two units in southeastern Ohio for management purposes no longer exists. Approximately 10 years later (or 3-4 bobcat generations), the locations of confirmed sightings indicate that these populations are no longer spatially distinguishable, and updated genetic analysis shows little to no indication of genetic clustering between these two previously delineated subpopulations (Heffern 2021), showcasing just how rapidly things have changed. Popescu et al. (2021) similarly recommended that habitat suitability and connectivity models be regularly updated, as bobcats colonize new areas of the state. The Ohio bobcat model has the flexibility to be adapted and updated to continuously monitor the population as new information becomes available.

Effective bobcat management in Ohio requires continued monitoring of bobcat populations. Recent research shows that the Ohio bobcat population could sustain limited levels of harvest under specific conditions (Dyck et al. 2023). If harvest opportunities are pursued in Ohio, monitoring harvest will also be an important component of bobcat management. Bobcats have lower reproductive potential, naturally occur at low to moderate densities, and have comparatively restricted distributions when compared to coyotes (*Canis latrans*), another mid-sized carnivore found in Ohio. Hence, detailed harvest information and monitoring is necessary to ensure sustainable populations.

CITES Designation

Bobcats are included in Appendix II of the Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES). The inclusion of bobcats in this Appendix is because they are a “look-alike” species for other *Lynx* species that are at risk. As such, the export of bobcat pelts from the United States is regulated and monitored by the U.S. Fish and Wildlife Service (USFWS). As of February 2021, all states with harvest seasons for bobcats were approved for export under the CITES Export Program. States and tribes must participate in this program in order to be able to provide successful trappers/hunters in their jurisdiction with CITES export tags. All states and tribes that participate in this program are required to monitor the bobcat populations in their jurisdiction and provide annual updates to the USFWS on the status of their bobcat populations and harvest regulations. On February 2, 2021, the USFWS Division of Scientific Authority issued a 5-year non-detriment finding for bobcat export from the United States stating, “the exportation of bobcat taken in the contiguous 48 States of the United States between 2020-2021 and 2025-2026 harvest seasons, will not be detrimental to the survival of the species.”

III. Ohio Bobcat Monitoring and Research

Annual Monitoring

Bobcat Sightings

Bobcat sighting reports have been the primary method used to track bobcat populations since they began to recolonize Ohio. These sighting reports provide a means for the Ohio Division of Wildlife to track changes in bobcat occurrence in the state over time. Bobcat sighting reports include observations reported to the Division of Wildlife by members of the public and observations made by Division of Wildlife personnel while in the field. Over the years of tracking sightings, the division has received and documented reports from the public submitted through the mail, in-person interactions, phone calls, and emails. In 2017, the division launched a wildlife reporting website to make it easier for the public to report sightings of bobcats and other species.

Once received, sightings are screened to eliminate duplicates (i.e., multiple reports from the same location within the same month) or sightings that are confirmed to be a species other than bobcat (e.g., house cat). If evidence confirms that the species observed was a bobcat, it is classified as a confirmed sighting. Otherwise, the sighting is considered unconfirmed.

From 1970 through 2021, there have been 4,159 confirmed reports of bobcats in Ohio. Prior to 2000, the Division of Wildlife never received more than five confirmed sightings in one year. In the early 2000s, bobcat sightings started to become a more frequent occurrence, and the number of bobcats observed each year accelerated (Figure 2). Of the confirmed bobcat reports since 1970, 4,131 occurred after 2000 (99%), and 3,682 have occurred since 2010 (86%). The number of unconfirmed sightings received each year show a similar increasing trend (Table 2).

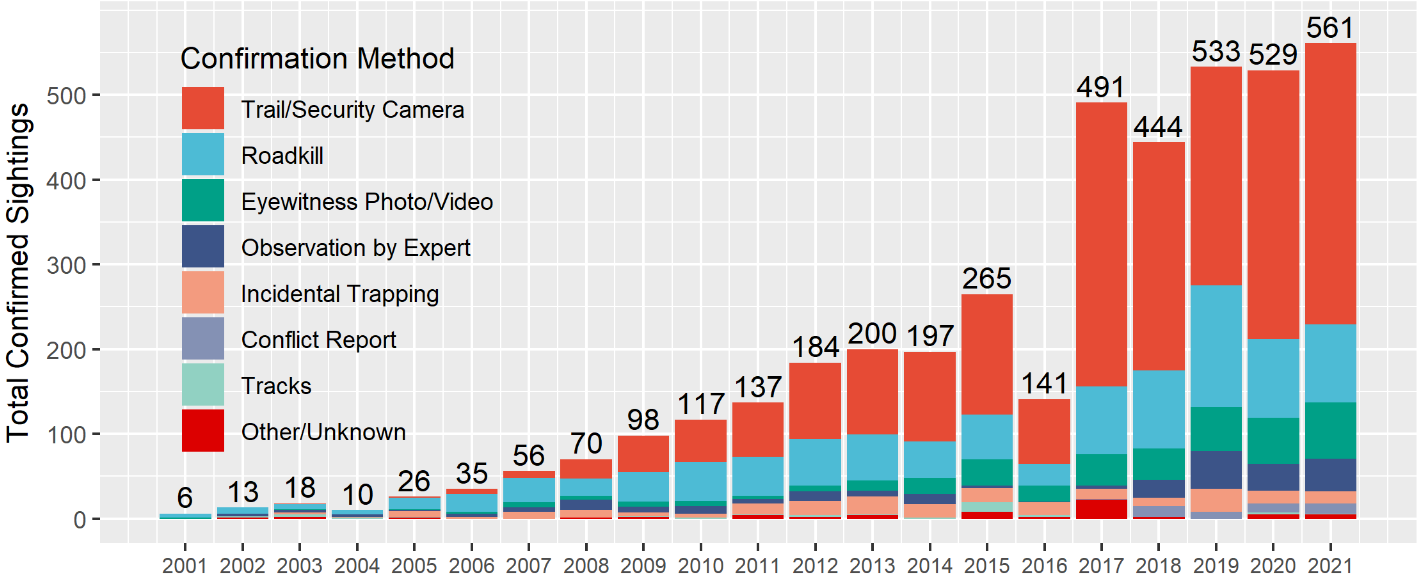


Figure 2. Total number of confirmed bobcat sightings per year in Ohio and method of confirmation for each sighting from 2001 to 2021.

Bobcat mortality, particularly vehicle-related, was historically the primary source of confirmed sightings. Since 2008, trail cameras have been the primary source of confirmation for bobcat sightings, with anywhere from 33-68% of confirmed sightings coming from trail camera pictures each year. Roadkill animals remain the second most common source of confirmed sightings. Other methods of confirmation are less common and include eyewitness photos, photos of tracks, observation by an expert (e.g., a Division of Wildlife staff member), incidental trapping reports, or nuisance reports.

Overall, confirmed sightings have increased over the past decade; however, the number has stabilized in recent years. Several factors should be considered when assessing the trend in confirmed sightings. The growing popularity of trail cameras, as well as the decline in their cost, is partially responsible for the increase in the receipt of trail camera photos of bobcats since 2000. However, the number of confirmed sightings reported, excluding trail camera pictures, still shows a steadily increasing trend over the past two decades. The launch of the Division of Wildlife's wildlife reporting website in 2017 made it easier for the public to report sightings. Sightings records are incomplete for 2016 because of staff turnover and data loss; however, at least some of the large increase in sightings observed between 2016 and 2017 may be attributed to the availability of the reporting website. Conversely, as bobcat sightings become a more regular occurrence in some areas of the state, people may be less likely to report their sightings to the division. Due to these confounding factors, changes in the number of sightings reported from year to year should be interpreted with caution, and not as an exact index of abundance.

Sightings are reported throughout the year but are most common from September through January (Figure 3). Increased bobcat activity occurs this time of year and is likely the reason for the increased number of sightings. In the fall, young bobcats begin to disperse from their mother's home range to establish their own range, and January is the start of bobcat breeding season in Ohio. This time of year also corresponds with hunting and trapping seasons, when people may be more likely to be in the field and encounter a bobcat, or have a trail camera set up, which may also account for some of the increase in sightings during this time.

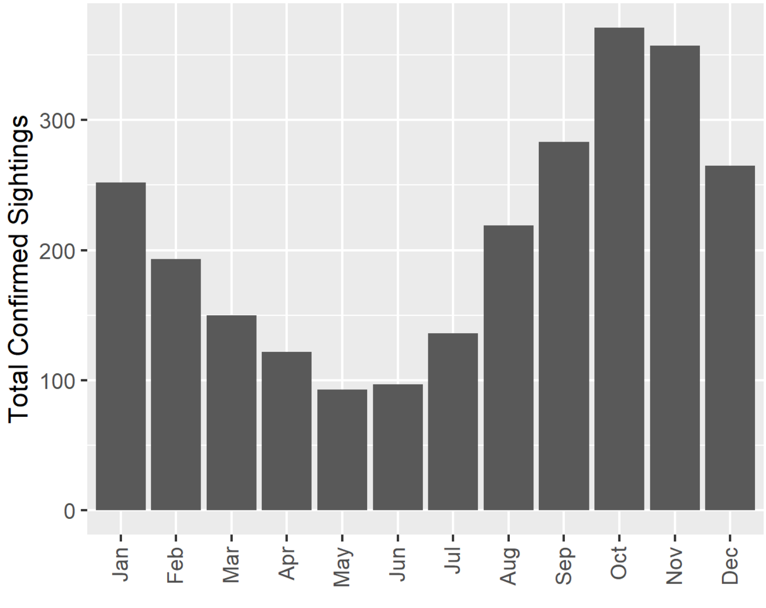
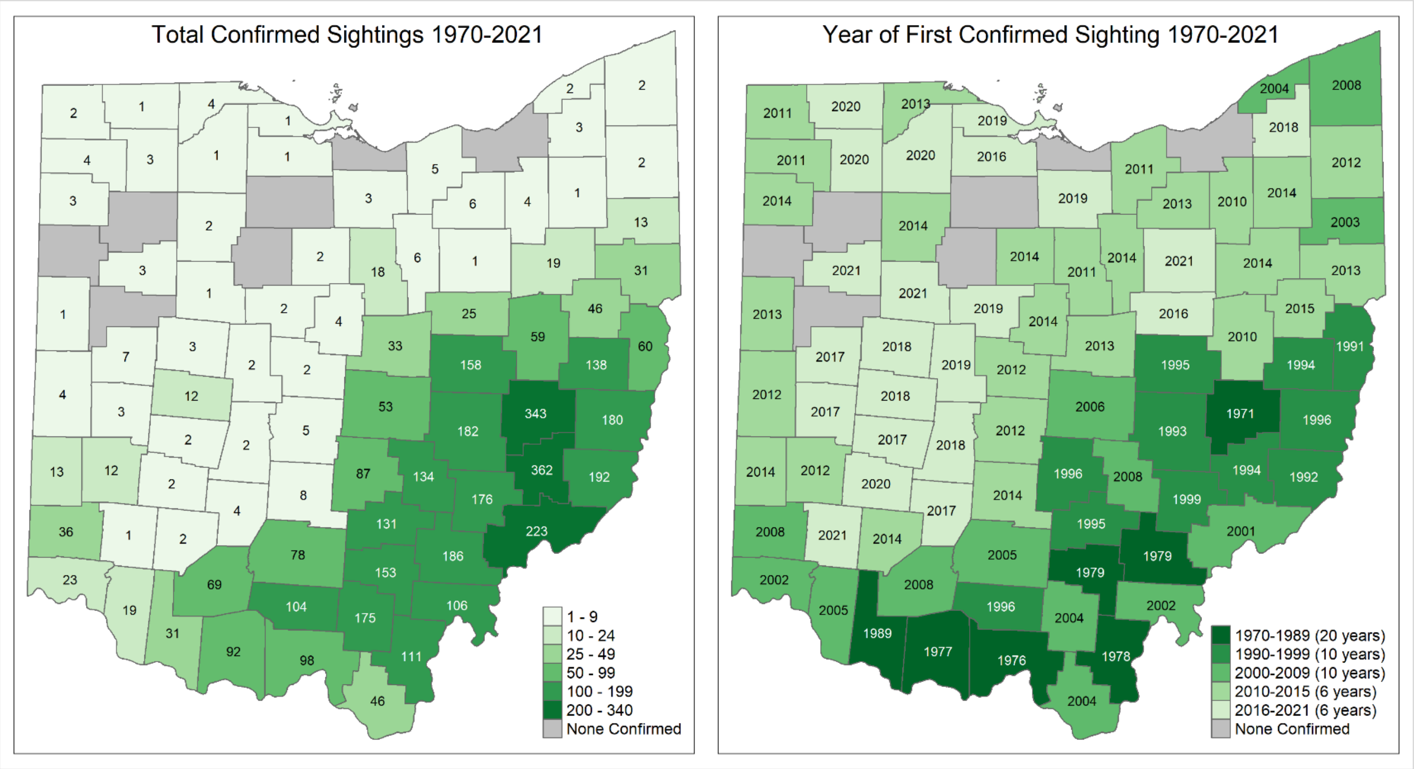


Figure 3. Total confirmed bobcat sightings in Ohio by month from 2017 - 2021.

Between 1970 and 2021, bobcat sightings were confirmed in 81 counties. Genetic research conducted from 2002 to 2012 showed that the distribution of bobcats in Ohio at that time was separated into two subpopulations, one in southeast Ohio (Noble County and surrounding areas) and one in southern Ohio (Jackson and Vinton counties and surrounding areas) (Anderson et al. 2015). The southeast and southern Ohio populations were established as bobcats dispersed from growing populations in Pennsylvania, West Virginia, and Kentucky (Anderson et al. 2015), and their establishment in this region was likely due to the combination of proximity to growing populations and sufficient availability of suitable habitat (Popescu et al. 2021). The earliest confirmed bobcat sightings in the state were documented in these areas, and sightings are still most common in these regions (Figure 4). However, as confirmed sightings have increased over the past decade, so have the number of townships and counties where sightings occur (Table 2). Confirmed bobcat sightings are now consistently reported each year throughout southeast and southern Ohio, with occasional confirmed sightings extending into northeast, central, and western Ohio. This suggests populations may be expanding from the core populations into new areas.


Total Confirmed Sightings 1970-2021

Year of First Confirmed Sighting 1970-2021

Figure 4. Total confirmed bobcat sightings (left) and year of first confirmed sighting (right) by county in Ohio from 1970 to 2021.

Bobcats are capable of dispersing long distances, and young cats may pass through areas of less suitable habitat as they search for a place to establish a home range. In the Midwest, bobcats have been documented travelling distances greater than 200 kilometers during dispersal (Johnson et al. 2010). Therefore, a single confirmed sighting does not necessarily indicate a resident population is present in the area. Bobcats are generally solitary, with the exception of males and females during breeding, and females with dependent young. As bobcats continued to expand in Ohio, the Division of Wildlife began tracking evidence of multiple cats in an area to better understand what parts of the state are supporting resident reproducing bobcat populations versus what areas may just be seeing the occasional dispersing individual.

While sightings are less common in far southwest Ohio (Butler and Hamilton counties), females with kittens have been observed in these counties in recent years, indicating that a small resident population is present in this area. Sightings in northeast Ohio are uncommon and evidence of reproduction has not yet been documented in this part of the state; however, research shows that portions of this area may contain sufficient habitat to support a resident population in the future (Popescu et al. 2021). Sightings are also rarely confirmed in counties in central and northwest Ohio that are dominated by agriculture, and evidence of reproduction has not been observed in these areas. Habitat suitability is low in these parts of the state and it is possible that these areas may never support resident populations; however, riparian forest corridors in these areas may provide sufficient habitat for dispersing animals (Popescu et al. 2021). Division of Wildlife staff expect to continue to see bobcats moving through these areas.

Given the numerous confounding factors involved in the use of sighting data as an index to relative abundance, implementing additional monitoring methods that can account for survey effort is warranted for tracking the trajectory of the bobcat population. This will be particularly important if a bobcat harvest season is implemented, in order to more thoroughly assess the population and any impacts from harvest. However, using sightings to track the distribution of bobcats, particularly where populations are not yet well established, will continue to be important for monitoring the Ohio bobcat population.

Table 2. Bobcat Sightings in Ohio from 1971 to 2021.

Year	Confirmed Sightings	Unconfirmed Sightings	Number of Counties with Confirmed Sightings*	Number of Townships with Confirmed Sightings*
1971	1	--	1	1
1975	--	3	--	--
1976	1	1	1	1
1977	2	3	1	2
1978	1	--	1	1
1979	2	--	2	0
1980	1	--	1	1
1987	--	1	--	--
1989	1	--	1	0
1990	1	--	1	1
1991	2	1	2	2
1992	1	10	1	1
1993	1	1	1	1
1994	3	1	2	2
1995	4	4	3	1
1996	4	8	4	4
1997	--	29	--	--
1998	1	32	1	1
1999	2	20	1	1
2000	--	35	--	--
2001	6	46	6	6
2002	13	35	10	8
2003	18	44	8	13
2004	10	60	10	10
2005	26	66	14	14
2006	35	29	16	29
2007	56	181	16	38
2008	70	221	23	49
2009	98	270	16	61
2010	117	307	22	80
2011	137	295	25	70
2012	184	244	32	117
2013	200	226	36	127
2014	197	176	39	131
2015	265	Not Available	35	119
2016	141	Not Available	32	79
2017	491	Not Available	46	259
2018	444	518	46	245
2019	533	448	48	284
2020	529	494	58	297
2021	561	648	57	295

*Note: This information may be incomplete, as some confirmed sighting records do not include township and/or county information.

Bowhunter Survey

The Ohio bowhunter observation survey has been conducted annually since 1990. Volunteer participants record the county where they hunted, the number of hours they spent in the field each day, and what species were observed. The Division of Wildlife relies on the bowhunter index (the number of observations per 1,000 hours spent in the field) to track the relative abundance of several species including gray fox, red fox, and coyote. While the division had asked about bobcat observations in a supplemental portion of the bowhunter survey for several years, they were not added to the main portion of the survey until the fall of 2020. In 2020, 6.7% of active bowhunter survey participants reported observing a bobcat on at least one hunting trip that year. In 2021, 7.8% of active survey participants reported at least one bobcat observation.

Statewide, bowhunters reported an average of 3.3 bobcats observed per 1,000 hours hunted in both 2020 and 2021. The rate of observations by bowhunters varies by county and generally shows a similar distribution to that of confirmed sightings (Figure 5). Bowhunter surveys as well as other types of hunter surveys are regularly used by other U.S. states to monitor their bobcat populations (Anderson and Lovallo 2003, Roberts and Crimmins 2010). Although observations reported on Ohio's bowhunter survey cannot be confirmed, the inclusion of a measure of effort (hours spent in the field) provides a useful means for standardizing observations to track changes in observation rate over time. The similarity between the distribution of sightings on the bowhunter survey and the distribution of confirmed sighting reports indicates that as more years of data from this survey become available, the Ohio bowhunter survey can provide a reliable method for tracking bobcat populations, while accounting for changes in effort.

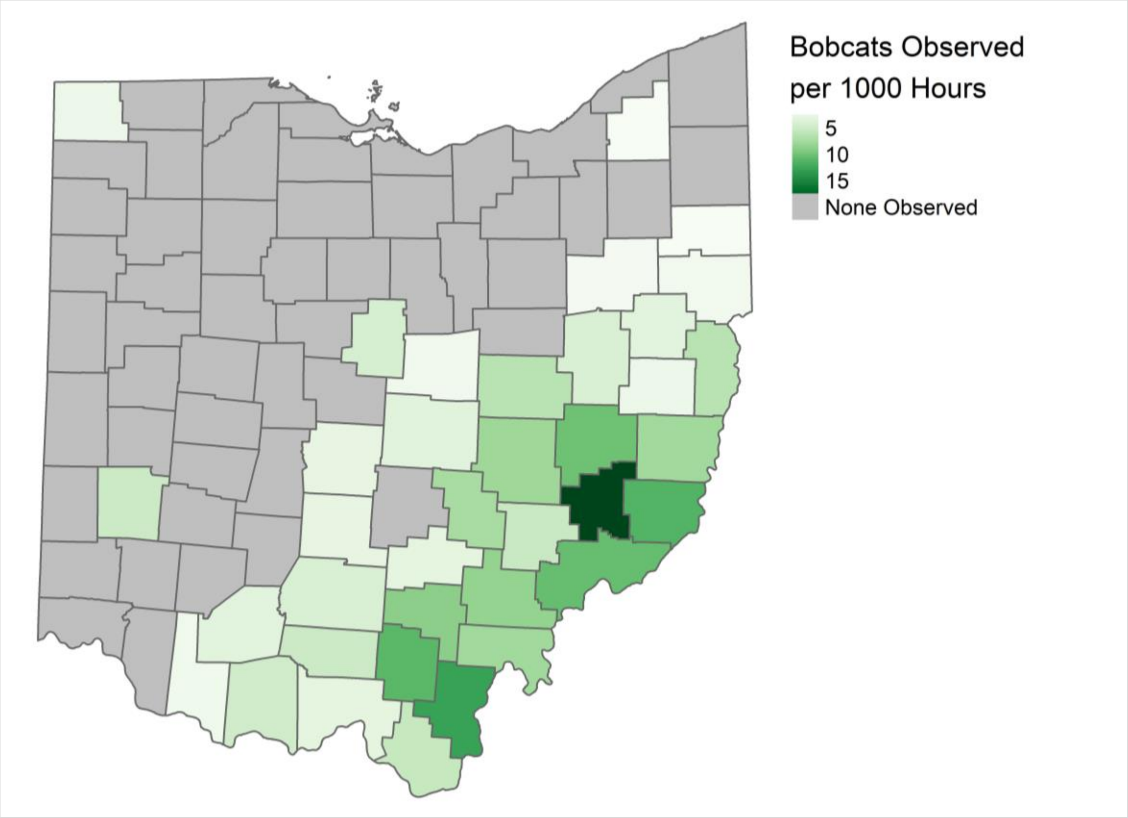


Figure 5. Bobcat observation rate by county (bobcats observed per 1000 hours in the field) on the 2021 Ohio Bowhunter Survey.

Research

As bobcats became more common in Ohio, the Division of Wildlife invested in research to better understand the status and resource needs of the Ohio population. Between 2000-2020, division staff collected over 300 roadkill bobcats. Necropsies of these bobcats were conducted by division staff or external researchers, and information collected was used to assess diet, genetics, age, and reproductive parameters. From 2011-2014, the division, in coordination with external researchers, assessed bobcat home range, habitat use, and mortality using GPS tracking collars. Lastly, in 2017, the division began funding a 4-year study at Ohio University to use multiple sources of information to develop management strategies for Ohio's recovering bobcat population. A selection of key results from these research projects are outlined below.

Bobcat Diet in Ohio

Rose and Prange (2015) described the diet of bobcats in Ohio based on examination of the stomach contents of 120 bobcat carcasses collected from 2002-2011. Remains of mammalian prey species in the stomach contents were separated and identified to the lowest taxonomic order possible based on identification of hair, body parts, or whole prey. Remains were then dehydrated and weighed by species for each bobcat. Bird and invertebrate remains were separated and weighed, but not identified to species. Frequency of occurrence of prey species was calculated as the number of stomachs in which that species was observed. For species that occurred in more than 5% of bobcat stomachs, the weight of dry remains and estimates of calories per gram of dry weight were used to estimate the proportion of calories contributed by each species to the overall bobcat diet.

Ten stomachs were empty and therefore excluded from analysis. In the remaining 110 stomachs, 15 mammalian prey species were identified, as well as mice, voles, birds, and arthropods which were not identified to species. No amphibian or reptile remains were detected in this study. Eastern cottontail were the most frequently observed species, found in 29 of 110 stomachs (26.4%), followed by white-tailed deer (21.8%). Small rodents and insectivores (chipmunks, flying squirrels, mice, voles, shrews, and moles) were the most common prey group, occurring in 32.7% of stomachs. White-tailed deer provided the highest portion of calories (27.7%); however, opossum and eastern cottontail were also found to be important species contributing to bobcat's caloric intake (Figure 6). (Rose and Prange 2015)

Adult bobcats (2 years old, or older) consumed significantly more meso-mammals and large rodents (raccoon, opossum, groundhog, and beaver) than subadults (0 – 1 years old), which may indicate a greater level of skill is needed for a bobcat to take these animals. No significant differences in diet were observed between males and females. The caloric contribution of white-tailed deer to the diet of bobcats was significantly greater during winter than summer. The authors suggested this may be due in part to limited accessibility to small rodents and insectivores which are less active or spend more time in burrows or tunnels during the winter months. White-tailed deer are accessible year-round and may be weakened by the stress of winter, making them more susceptible to predation during this time. Bobcats may also be scavenging remains of deer that die from other causes (e.g., starvation, harvest, roadkill, etc.), and this seasonal difference may be reflecting a difference in availability of deer carrion (Rose and Prange 2015).

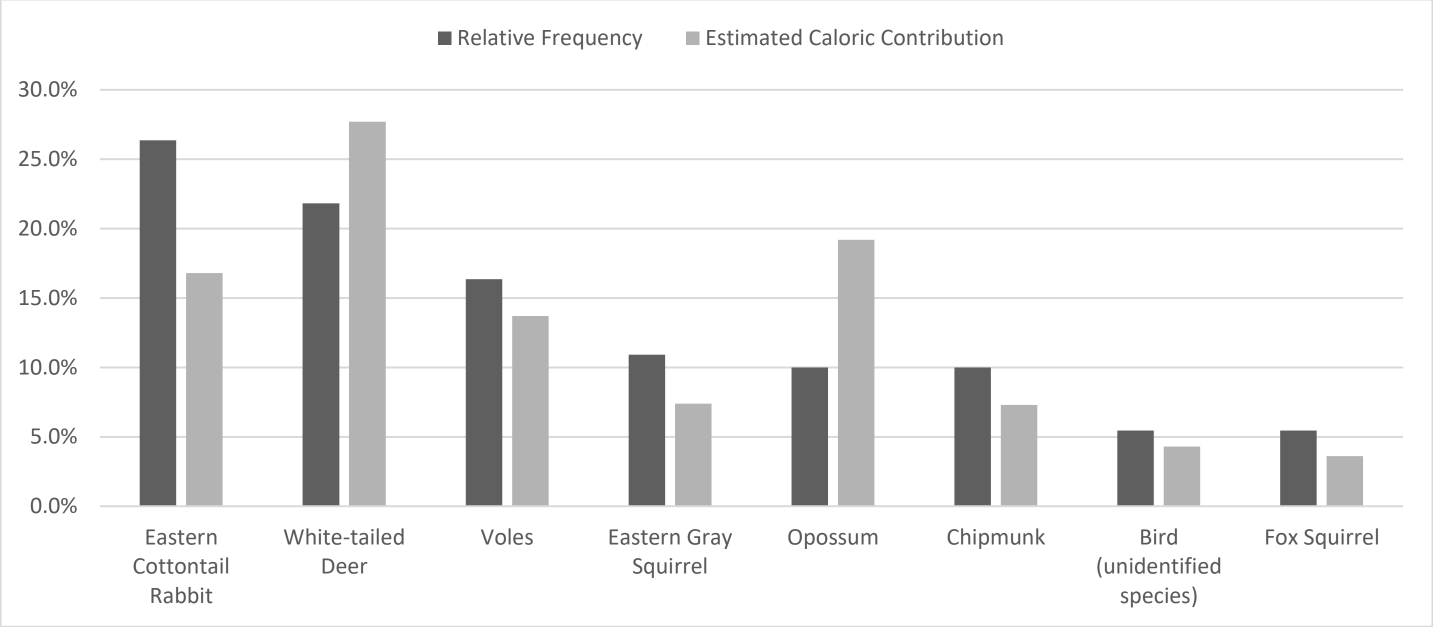


Figure 6. Relative frequency (proportion of stomachs in which species was observed) and estimated caloric contribution of 6 species as well as voles (Microtus spp.) and birds, which were not identified to species level, which occurred in ≥5% of bobcats collected in Ohio from 2002-2011. Adapted from results of Rose and Prange (2015).

Bobcat Genetics in Ohio

Anderson et al. (2015) analyzed genetic samples from bobcats collected in Ohio, as well as three neighboring states: Kentucky, West Virginia, and Pennsylvania. Their results showed that bobcats in southern Ohio (Jackson and Vinton counties and surrounding areas) were part of a genetic cluster than included bobcats from Kentucky, West Virginia, and western Pennsylvania. In contrast, most bobcats collected in the eastern part of Ohio (Noble County and surrounding areas) were genetically distinct from that multistate subpopulation, and evidence suggested that the eastern Ohio population likely originated from the migration of relatively large numbers of individuals from a source population. While levels of genetic variation were slightly lower in eastern Ohio than in the multi-state population, the authors found evidence that migration was occurring from the multi-state population into the eastern Ohio population, and there was no evidence of a bottleneck or elevated levels of inbreeding in the eastern Ohio population. The authors recommended at the time that management of Ohio bobcats should allow for two separate management units defined by the areas occupied by these two genetically distinct populations. They also suggested that population structure should be assessed on a regular basis until the eastern population is no longer distinguishable.

Samples used in the research conducted by Anderson et al. (2015) were collected from 2002 to 2012. Heffern (2021) revisited the genetic relatedness of bobcats in Ohio using 118 samples collected in 2019 and 2020. Based on the work of Anderson et al. (2015), samples collected from Washington, Morgan, Perry, Muskingum, Noble, Monroe, Guernsey, Coshocton, Belmont, Knox, Richland, and Tuscarawas counties were considered to be from the eastern population, and samples collected in Fairfield, Hocking, Athens, Meigs, Vinton, Gallia, Lawrence, Ross, Jackson, Scioto, and Pike counties from the southern population. They found little to no indication of genetic clustering between these two previously delineated subpopulations. While some results indicated that there may still be limited residual genetic differentiation, overall, the study showed evidence of a converging bobcat population with increased admixture occurring since the previous study (Anderson et al.

2015). Heffern (2021) suggested that based on these results, the Ohio bobcat population could now be considered a single management unit from a genetic perspective.

Bobcat Health, Mortality, and Survival in Ohio

Capture and Monitoring Methods

From 2012–2015, the Ohio Division of Wildlife, in collaboration with external researchers, trapped, immobilized, collared, and monitored 28 bobcats in two study areas in southeastern Ohio. The two study areas were selected based on the two populations identified in Anderson et al. (2015). In the eastern study area, bobcats were trapped on Ales Run Wildlife Area, B&N Coal's Middleburg Hunting Area, and a portion of AEP ReCreation Land (now Appalachian Hills Wildlife Area, Jesse Owens State Park, and Jesse Owens Wildlife Area) in Noble and Morgan counties. In the southern study area, bobcats were trapped on Vinton Furnace State Experimental Forest in Vinton County. (Prange 2014, Prange and Rose 2020)

Bobcats were trapped using foothold traps during the winter and early spring, beginning in January 2012 and ending April 2014. Captured bobcats were immobilized while researchers took standard measurements, including weight and body length, photographed each cat, inserted subcutaneous PIT tags between their shoulder blades, and collected blood, a hair sample for DNA, and a fecal sample. Adult and subadult bobcats which met weight standards for receiving a monitoring collar (e.g., the collar weight was less than 5% of the bobcat's weight) were fitted with either a GPS or VHF radiotelemetry monitoring collar. Captured bobcats were released at the capture site upon complete recovery. (Prange 2014, Prange and Rose 2020)

Twenty-four bobcats (13 male, 11 female) were monitored with GPS collars. Collar models included Telemetry Solutions Quantum 4000 (Telemetry Solutions, San Francisco, CA, USA) which were programmed to record locations twice a day at 12-hour intervals on a staggered system that rotated through a 24-hour period (i.e., 12:00, 24:00; 1:00, 13:00; 4:00, 16:00; etc.). Tellus GPS System collars (Followit, Lindesberg, Sweden) were also used on some cats and recorded locations twice a day with a rotating schedule of 4 templates (03:00, 15:00; 06:00, 18:00; 09:00, 21:00; 12:00, 24:00). Both models of GPS collars required close-range remote download to retrieve GPS data and were equipped with VHF transmitters with mortality signals. An additional four males were monitored with VHF-only collars equipped with mortality signal capability (Advanced Telemetry Systems, Isanti, MN, USA). (Prange 2014, Prange and Rose 2020)

Bobcats were located using ground telemetry 2–3 times per week to check for mortality signals and to determine if females were denning with young. In the event that a GPS collar began to fail to download locations (and for animals with VHF-only collars), a ground-based location protocol was implemented. Field personnel located study animals via ground-based VHF telemetry and triangulation at least 2-3 times per week, alternating through six time blocks to ensure 24-hour activity coverage. Bobcats were also located using aerial telemetry (via helicopter or fixed-wing aircraft) every 2–3 weeks. Mortality signals were investigated to recover the animals and determine the cause of death. (Prange 2014, Prange and Rose 2020)

Health and Mortality

A body condition index equal to (weight/body length)*100 was calculated for each bobcat. Bobcat condition indices varied by site ($H = 6.61$, $P = 0.010$, $n = 27$), with bobcats in the southern study area being in poorer condition (southern $n = 9$, mean ± s.e. = 10.27 ± 0.95 kg/cm; eastern $n = 18$, mean ± s.e. = 13.35 ± 0.67 kg/cm)

(Prange and Rose 2020). This finding differed from an earlier report from Rose and Prange (2015) which found no significant difference in body condition scores between the southern study area and eastern study area for roadkill carcasses collected year-round in Ohio. Prange and Rose (2020) noted that the condition indices of these collared bobcats were based on measurements taken only during the winter, and the tougher conditions during this time of year may have highlighted the differences. This finding supports other evidence (larger home range sizes and lower densities for bobcats in southern Ohio) which suggests that bobcats in southern Ohio may need to cover larger areas and therefore expend more energy than those in eastern Ohio to find adequate resources (Prange and Rose 2020). It is also possible that this difference was influenced by the differing genetics of these two groups (Rose and Prange 2015, Prange and Rose 2020).

Blood samples from all captured bobcats were tested for feline immunodeficiency virus, feline leukemia virus, and feline heartworm by Briarhill Veterinary Clinic in Albany, Ohio. The clinic also performed a blood smear, fecal analysis, and measured packed cell volume and total protein. Disease did not appear to be a factor in mortality. All bobcats tested negative for feline immunodeficiency virus, feline leukemia virus, and feline heartworm, and other blood parameters were indicative of healthy individuals (Prange 2014).

Due to collar malfunction, the fate of several bobcats during this study could not be determined. Five bobcat mortality events were confirmed over the course of the study: three were hit on roads, one was suspected of being poached (the collar was found cut off), and one was killed by a canid, likely a coyote (Prange 2014).

Survival Estimates

Monitoring data from collared bobcats was used to estimate annual survival of adult bobcats in Ohio. Due to loss of collar signals, we did not have an adequate sample size to compare survival rates between sexes or study sites. Survival was estimated using a Kaplan–Meier Estimator. Average annual survival was 0.686 (95% CI 0.485–0.971).

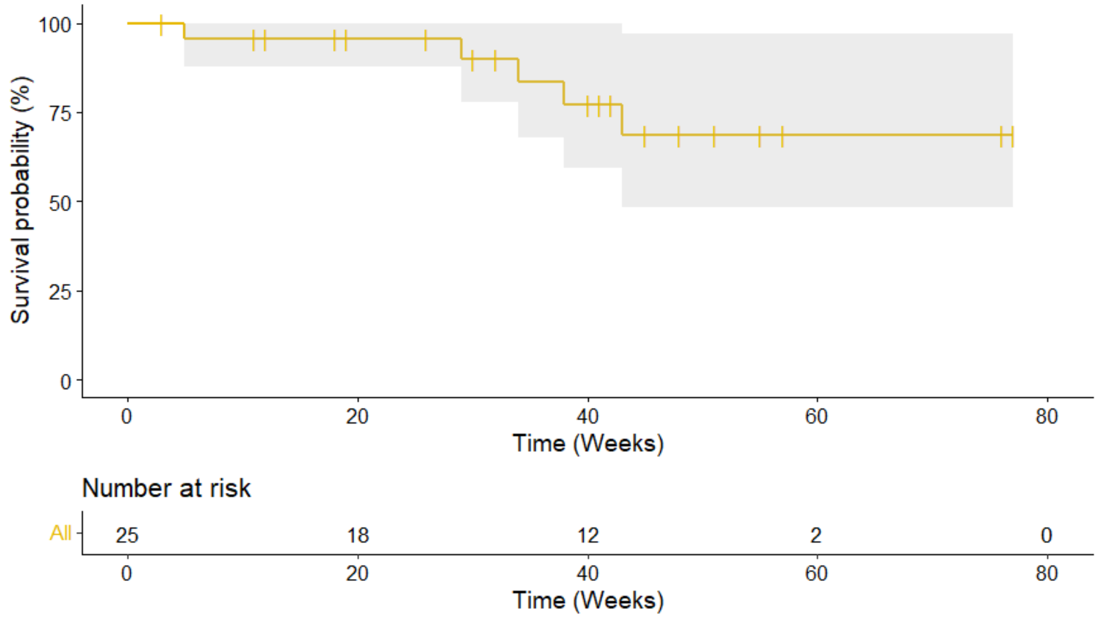


Figure 7. Survival plot for 25 adult bobcats monitored in Ohio from 2012 to 2015. Vertical lines indicate animals that were censored (collar signals lost, collars removed, etc.), so their fate was unknown. Week 1 starts on the day that each bobcat was collared.

Movements and Home Range

Prange and Rose (2020) used the fixed kernel method to estimate home range and core use areas for bobcats fitted with GPS and VHF monitoring collars in Ohio, and measure home range overlap (see "Bobcat Health, Mortality, and Survival" section for additional information on collaring methods and study areas). Both male and female home ranges were significantly larger in the southern study site than the eastern study site. Average home range size for males ranged from 34.7 km^2 (eastern) to 99.7 km^2 (southern) and for females ranged from 14.1 km^2 (eastern) to 44.9 km^2 (southern). Bobcat home range size, particularly for females, is thought to be primarily driven by the availability of resources in an area (Anderson and Lovallo 2003). The differences observed in bobcat home range size between the two study sites indicate that the eastern region may provide better habitat or a more abundant prey base than the southern region (Prange and Rose 2020). In general, percentage of overlap for two adjacent home ranges was low whether for males with other males, females with other females, or males overlapping females, and did not differ by study site. The mean overlap for different pair types and study areas ranged from 0.080 to 0.224 (Prange and Rose 2020).

Prange and Rose (2020) also measured straight-line distance between recorded locations that were 12 hours apart to get an idea of travel rates for bobcats in Ohio. Distances averaged by sex and study site ranged from 1.10 kilometers per 12 hours for females in the east to 2.08 kilometers per 12 hours for males in the south.

One collared yearling male bobcat dispersed a straight-line distance of approximately 57 kilometers from its natal range and settled into a new range (Prange and Rose 2020, Rose et al. 2020). A collared adult male was also observed making a long-distance movement of 165 kilometers (straight-line distance) from its capture location (Rose et al. 2020).

Bobcats and Roads

Roadkill was the most commonly documented source of mortality for collared bobcats in Ohio. Although malfunctions resulted in the inability to determine the fate of many collared bobcats in this study, research in other states has also documented roadkill to be an important factor impacting bobcat survival. Bencin et al. (2019) used bobcat roadkill data collected in Ohio from 1978-2017 and GPS telemetry data from bobcats collared in Ohio to determine predictors of bobcat roadkill mortality and assess the impact of roadkill on the Ohio bobcat population.

The locations of documented roadkill and a randomly generated set of points along roads in counties with documented roadkill were used to evaluate a set of logistic regression models to determine if landscape or road trait variables were useful for predicting bobcat road mortality. GPS collar data was used to estimate the number of road crossings made by individual bobcats and measure the road density within each collared bobcat's activity area. The researchers also used a Correlated Random Walk (CRW) algorithm to simulate a dataset of random movement data for each bobcat, which was used to determine if the collared bobcats exhibited road avoidance behavior. Lastly, bobcat space use and road crossing data and Ohio Department of Transportation traffic data were used to map road mortality probability within the study area and estimate the proportion of the bobcat population likely to be killed on roads.

Bencin et al. (2019) determined that both landscape and road variables were important for predicting bobcat road mortality. Roadkill mortality was positively associated with interstate highways, road density, and percent of forested land cover within a 1,000-meter buffer of the site and negatively associated with township roads and the percent of developed lands within a 1,000-meter buffer. Collared bobcats crossed roads frequently; the mean number of crossings per year for females was 178, and males was 195. Bobcats did display some avoidance of municipal, county, and U.S. routes within their activity areas, although avoidance patterns differed by sex. Interstate roads were not present in the activity areas of any collared bobcats, so activity in relation to interstates could not be evaluated. The authors estimated that between 6-18% of the bobcat population in Ohio is killed on roads annually, and recommended, given the high density of roads in Ohio, and the potential for growth in road density and traffic rates, that the impact of roadkill be incorporated into bobcat population assessment and management planning in the state.

In modelling the population viability of Ohio's bobcat population, Dyck et al. (2023) built on this work by mapping road mortality risk on a statewide 10 x 10 kilometer grid. Road mortality risk for each grid cell was calculated by summing the lengths of each of four high-traffic road categories (Interstate, U.S. Route, State Route, and County Route), weighed by the annual risk of mortality for a female crossing roads at the average rate of 178 crossings per year at the median level of traffic for each road type (Figure 8). The map was then used to model the potential impact of future traffic increases on bobcat population viability (See Spatial Population Viability Model Section).

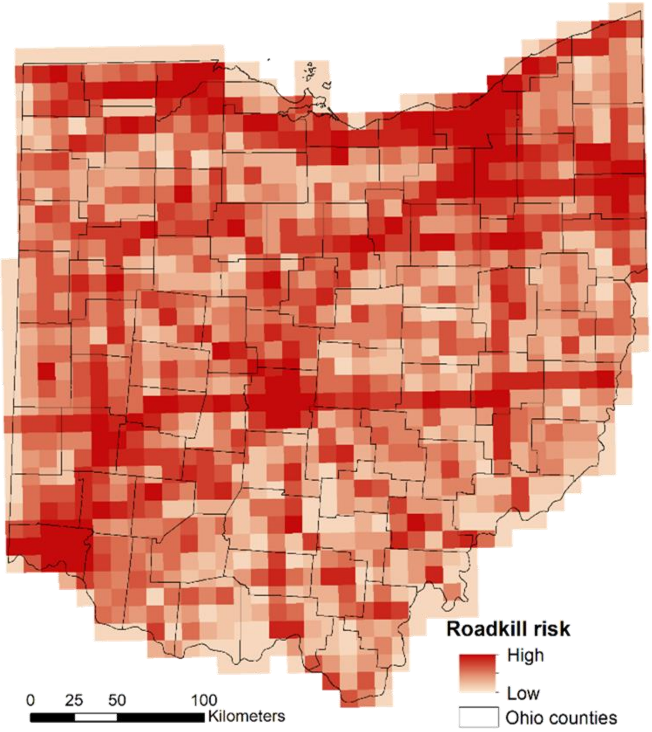


Figure 8. Ohio bobcat road mortality risk map. Source: Dyck et al. (2023) supplementary information.

Habitat Suitability and Connectivity

Popescu et al. (2021) looked at resource selection for bobcats in Ohio and created maps of bobcat habitat suitability and connectivity based on information from previously collected datasets. Population level habitat selection for bobcats in Ohio was evaluated using 975 locations of confirmed bobcat sightings (excluding roadkill) collected from 2010–2019. A set of 16 candidate models was evaluated including variables of proportion of forest, pasture, and herbaceous vegetation at various scales, and distance to roads, and the top-ranked models were used to map bobcat habitat suitability across the state. The habitat suitability map was then used to model habitat connectivity between five different areas of the state. Individual level habitat selection was assessed using GPS collar data from 20 adult bobcats monitored between 2012 and 2014. Selection for habitat within each individual's home range was assessed using generalized linear models and Resource Selection Functions.

Within their individual home ranges, bobcats showed strong selection for forest habitat, areas with low road density, and areas that were farther from high traffic roads. At the population level, the top model indicated a strong positive relationship between the proportion of forest within a 50 km^2 buffer of a given site and bobcat habitat suitability. Other competitive models also indicated positive relationships between habitat suitability and the proportion of pasture within 50 km^2, the proportion of natural herbaceous vegetation at several scales (15, 30, and 50 km^2 buffers), and distance to high traffic roads. Habitat suitability was highest in southeast and southern Ohio where forest cover is abundant. Suitability was also moderate to high in some portions of southwest and northeast Ohio. Most of central and northwestern Ohio had low habitat suitability, with the exception of some small patches of habitat along river corridors (Figure 9).

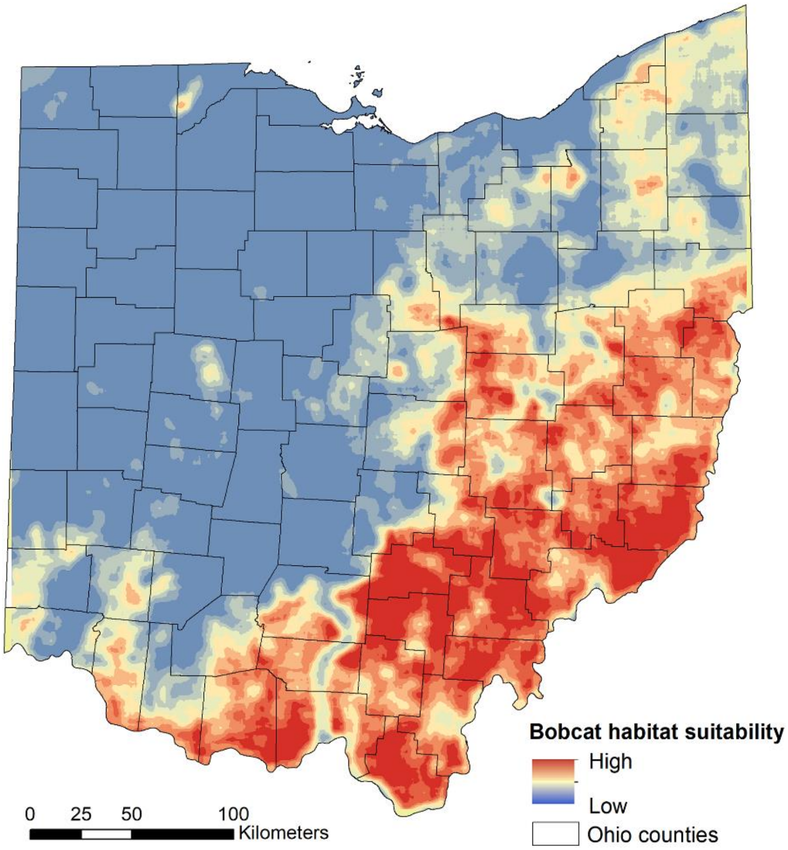


Figure 9. Model-averaged predictions of population-level bobcat habitat selection (suitability). Source: Popescu et al. 2021.

Habitat connectivity was assessed between five counties which were selected either on the basis of having established bobcat populations (Noble and Vinton counties) or having confirmed sightings in recent years (Butler, Defiance, and Geauga counties). Connectivity was high between the established populations in southeast and southern Ohio, as well as between the established populations and northeast Ohio (Figure 10). The Ohio river valley provides a corridor to connect established southeast and southern Ohio populations to southwest Ohio. Habitat connectivity was low in central Ohio, but riparian corridors in western and northern Ohio showed moderate connectivity and may serve as dispersal routes for bobcats to the northwestern portion of the state.

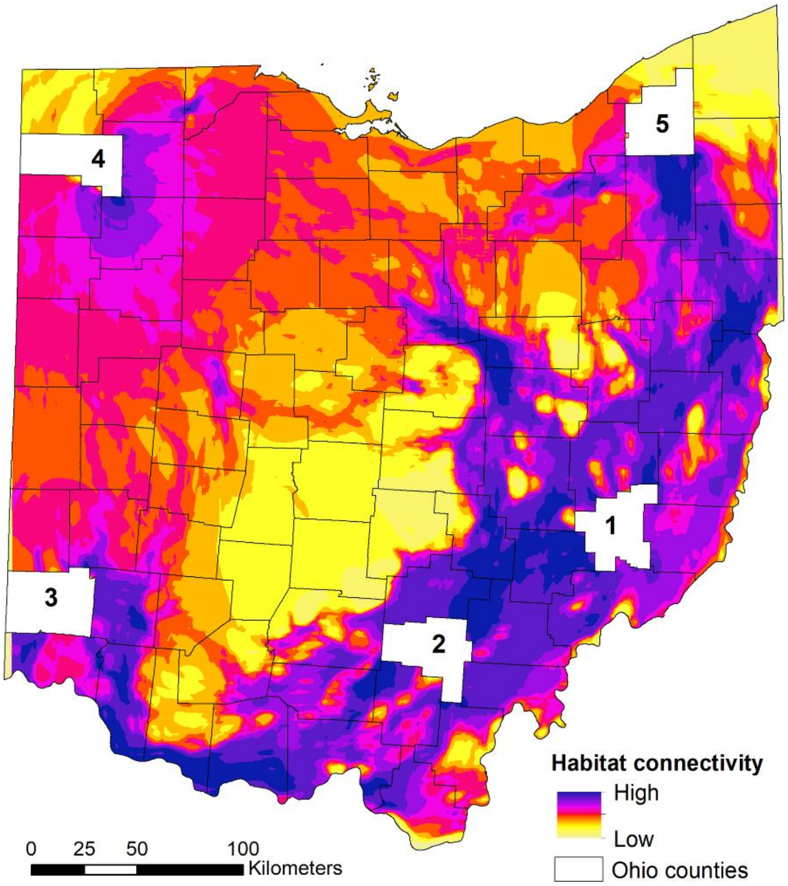


Figure 10. Statewide habitat connectivity for bobcats in Ohio. Source: Popescu et al. 2021.

The habitat suitability and connectivity models were created using the sighting data available at the time. As the bobcat population continues to expand and occupies new areas it is recommended that the Division of Wildlife update these models based on newly available sighting locations, which may offer additional insight into bobcat habitat suitability in the state.

Density Estimates

Researchers at Ohio University estimated bobcat density for two areas in southeast Ohio using spatial genetic capture-recapture techniques (Dyck et al., in review). Carnivore scat was collected along transects on AEP ReCreation lands (now Appalachian Hills Wildlife Area, Jesse Owens Wildlife Area, and Jesse Owens State Park) in Noble, Morgan, and Muskingum counties and on Vinton Experimental Forest and Zaleski State Forest in Vinton and Athens counties. These two areas were selected to overlap with areas where bobcats were previously collared and monitored, and to represent the populations identified through earlier genetic work, with the AEP area representing the eastern population, and the Vinton/Zaleski area representing the southern population (see previous sections). Transects were run three times between July 2018 and April 2019. Bobcat scats were genotyped to identify individuals. Capture histories were then built for each individual animal and analyzed using Spatially Explicit Capture-Recapture (SECR) models to estimate density of bobcats on AEP and Vinton/Zaleski.

Based on qPCR species identification, a total of 200 bobcat scats were collected on the AEP study area and 98 on the Vinton/Zaleski study area, although not all were successfully genotyped to identify the individual bobcat (Table 3). Density estimates on the AEP study area were over 1.5 times higher than estimates on the Vinton/Zaleski study area. The difference in estimated densities is consistent with the findings of Prange and Rose (2020) who observed smaller home range sizes, and greater catch per unit effort in the eastern population as compared to the southern population. There were also fewer individual bobcats identified on Vinton/Zaleski, despite higher survey effort.

Table 3. Number of bobcat scats genotyped, individual bobcats identified, length of transects surveyed, and estimated bobcat density on 2 study areas in Ohio in 2018-2019.

Study Area	Bobcat Scats Genotyped	Individual Bobcats Identified	Total Length of Transects	Density Estimate (Bobcats/100 km^2 ± SE; 95% CI)
AEP (Eastern)	63	33	225 km	17.9 ± 4.3; 9.47 – 26.33
Vinton/Zaleski (Southern)	39	22	276 km	11.3 ± 2.9; 5.62 – 16.984

The observed differences in density may be caused by varying habitat and resource availability on the two sites. While both of these study areas are largely forested, the eastern site has a comparatively more fragmented landscape, consisting of forest interspersed with pasture and grassland. Popescu et al. (2021) found bobcats in Ohio selected for areas with large proportions of forest cover, but also selected for areas with high proportions of herbaceous vegetation, suggesting that that heterogenous habitat on the eastern study area would provide a variety of preferred habitat for bobcats. Prange and Rose (2020) noted that collared bobcats in eastern Ohio had significantly higher body condition scores than those in southern Ohio, and suggested that the observed differences in space use and body condition between these areas may be driven by differences in habitat (and associated prey availability) created by differing mine reclamation methods, while also noting that some of the discrepancy may be due to differences in genetics between the two populations which could change over time as the population becomes panmictic. Bobcat sightings in the area of the southern population and between the southern and eastern populations have continued to increase since the initial telemetry study, and recent genetic analysis suggests that these two populations are converging (Heffern 2021). However, the density estimates produced by Dyck et al. (in review) indicate that as of 2018–2019, bobcats in the eastern population remained more densely populated than the southern population area; therefore, a conservative approach to managing the Ohio bobcat population should take into account these differences in abundance.

Spatial Population Viability Model

Dyck et al. (2023) used multiple sources of data on Ohio bobcats to develop a spatial population viability model which simulates the potential long-term viability of Ohio bobcats in response to possible harvest scenarios and varying levels of road mortality. The state was divided into 10 x 10 kilometer square blocks and the bobcat habitat suitability model (Popescu et al. 2021) was used to assign a maximum population size in each block, assuming a positive relationship between habitat suitability and maximum population size. Roadkill is the main source of mortality for bobcats in unharvested populations (Nielsen and Woolf 2002, Riley et al. 2003, Bencin et al. 2019). Statewide roadkill risk was mapped on the same 10 x 10 kilometer grid using information from Bencin et al. (2019), and was used to assess the impact that expected future traffic increases may have on the bobcat population. Vital rate ranges from Ohio bobcats and other non-harvested populations were used to simulate population trajectories under 26 scenarios. For each scenario, the population trajectory over 40 years was simulated 300 times.

Two baseline model scenarios assumed current conditions (no harvest permitted, no additional road mortality) and modelled the population trajectory with two potential density ceilings (a maximum of 30 bobcats per 100 km^2 or a maximum of 20 bobcats per 100 km^2). Different harvest implementations (e.g., method of take, bag limits versus limited permits, etc.) may impact the segment of the population that is harvested (Allen et al. 2018). Therefore, potential harvest scenarios modelled what the impact of harvest would be if all ages of bobcats were susceptible to harvest, or if only adult bobcats (2 years or older) were susceptible to harvest. Under each of these potential harvest scenarios, Dyck et al. (2023) simulated the impact of harvesting approximately 5%, 10%, or 15% of the population annually both with and without additional road mortality factored in, using the two potential density ceilings.

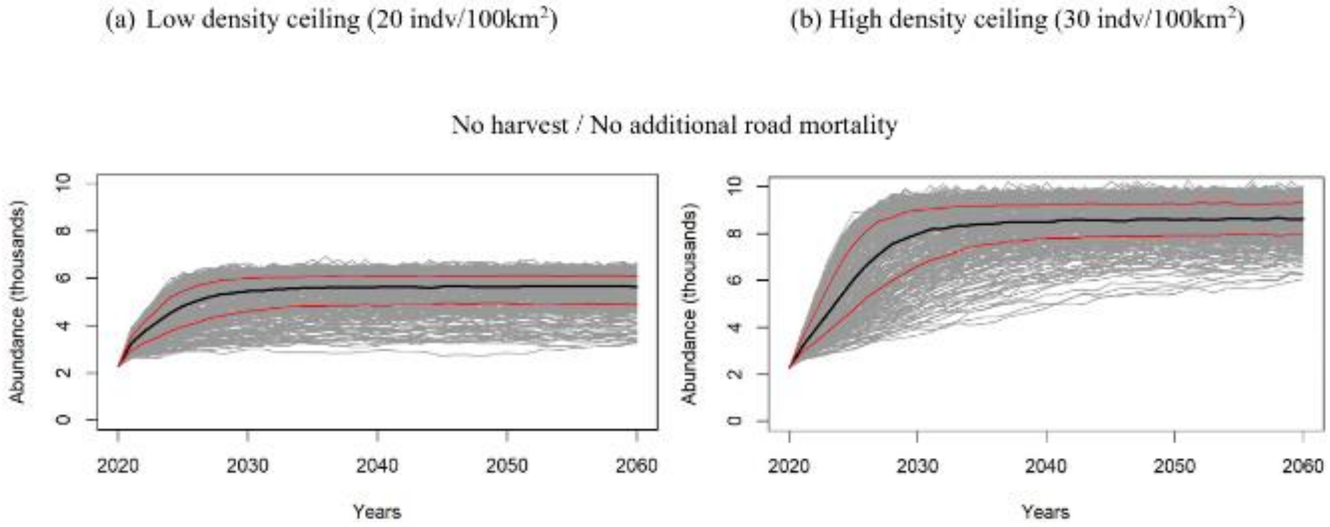


Figure 11. Baseline simulated population trajectories (no harvest and no additional road mortality) for Ohio's bobcat population comparing a high (30 bobcats per 100 km^2) and low (20 bobcats per 100 km^2) density ceiling with a starting population of 12 individuals per grid cell, adjusted by habitat suitability. Source: Dyck et al. (2023).

The baseline scenarios showed little to no risk of extinction over the next 40 years (Figure 11). Both in the baseline and harvest scenarios, when the density ceiling was lower, the population trajectory showed more uncertainty, and took longer to reach equilibrium. There was low risk of extinction both with and without additional roadkill risk at low levels of harvest (approximately 5% of population annually) and when all ages of bobcats were susceptible to harvest. However, increased uncertainty and possibility of extinction occurred with increased harvest levels and when only adult bobcats were susceptible to harvest (Figure 12). Higher levels of harvest (approximately 10% or more of the population annually) were unsustainable when increases in roadkill risk were factored in.

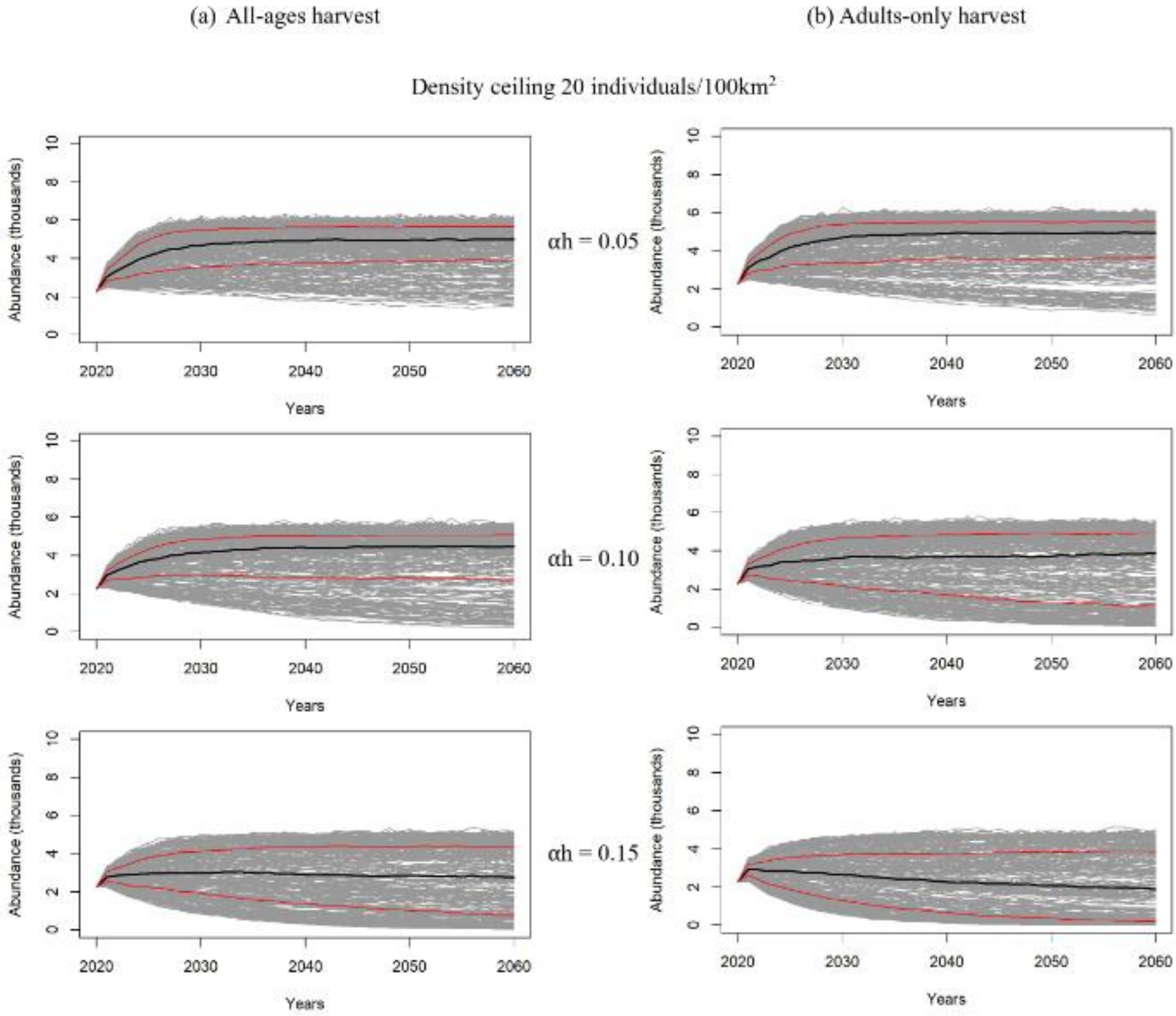


Figure 12. Simulated population trajectories for Ohio's bobcat population under varying levels of harvest intensity (αh) distributed across all animals (column a) and adults only (column b). Source: Dyck et al. (2023)

The scenarios explored in Dyck et al. (2023) show a selection of potential scenarios and how they may impact the Ohio bobcat population. However, the model framework allows for this tool to be used to address many other scenarios and to incorporate new data as it becomes available. This initial analysis provides several important insights into the potential impact of harvest on bobcats in Ohio, while also highlighting the unknowns that would need to be carefully monitored if a season were implemented. For example:

- Relatively small increases in the proportion of the population harvested led to increased impacts on the population trajectory. If harvest is implemented, conservative harvest limits with flexibility to make changes from year to year and careful monitoring of the population will be important to ensure that harvest is sustainable.

- The age and sex distributions of the animals that are harvested impacted the population trajectory. If harvest is implemented in Ohio, careful consideration should be given to how specific regulations may impact which animals are likely to be harvested. These models looked at two general scenarios, but if a season is implemented tracking the age and sex of harvested bobcats through mandatory submission of carcasses and incorporating this information into the model will be essential to fully assessing the impact of harvest.
- These models assumed harvest was permitted across the state (although simulated harvest effort varied in relation to habitat suitability, i.e., areas with higher suitability had higher harvest effort). However, the model framework allows for the ability to incorporate harvest zones into the model to more realistically assess the potential impact of specific harvest recommendations.
- Maximum population density impacted the uncertainty in population trajectories and the growth rate. Incorporating Ohio-specific or even zone-specific population densities into the model would help to refine the model.

Management Zones and Population Estimates

The Division of Wildlife established five management zones based on information from research and sightings (Figure 13; Figure 14). These zones are intended to be used to guide population monitoring and management, with needs and goals varying by zone. Zones A and B represent areas with high habitat suitability and are fully occupied based on the current distribution of sightings. These zones represent the areas where bobcats are well-established. This area was divided into two zones based on the previous research that found genetic differentiation between bobcats in eastern (Zone A) and southern (Zone B) Ohio (Anderson et al. 2015). Recent genetic evidence shows that bobcat populations in these areas have converged, with little to no genetic differentiation now occurring, in contrast to results from just 10 years earlier (Heffern 2021). However, the population density estimate for eastern Ohio was higher than the population estimate for southern Ohio (Dyck et al., in review). It may be expected that southern Ohio densities will increase as the two populations continue to converge. Both areas have similarly high habitat suitability throughout, and it’s possible that in time, they may be able to be managed as one unit. However, as the populations in this area may not yet be in a state of equilibrium, it is recommended to manage these as separate units for the time being.

Zones C and D represent areas in southwestern and northeastern Ohio that are not yet fully occupied based on sightings but that have moderate to high habitat suitability and high connectivity to established populations. The Division of Wildlife expects to see continued population growth in these management zones in the coming years. Zone E is comprised of areas of the state with low habitat suitability and low to moderate connectivity to established populations. This portion of the state may be limited in its ability to sustain resident populations of bobcats; however, continued dispersal by individuals throughout this zone is anticipated.

The Division of Wildlife estimated the size of the bobcat populations in Zones A and B. The division used the aggregated 10 x 10 kilometer grid cell habitat suitability map from Dyck et al. (2023) and assumed a linear relationship between density and habitat suitability. A population range for each zone was estimated using the upper and lower ends of the 95% confidence intervals of the density estimates produced by Dyck et al. (in review). This resulted in estimates of 1,010–2,807 bobcats in Zone A and 413–1,249 bobcats in Zone B.

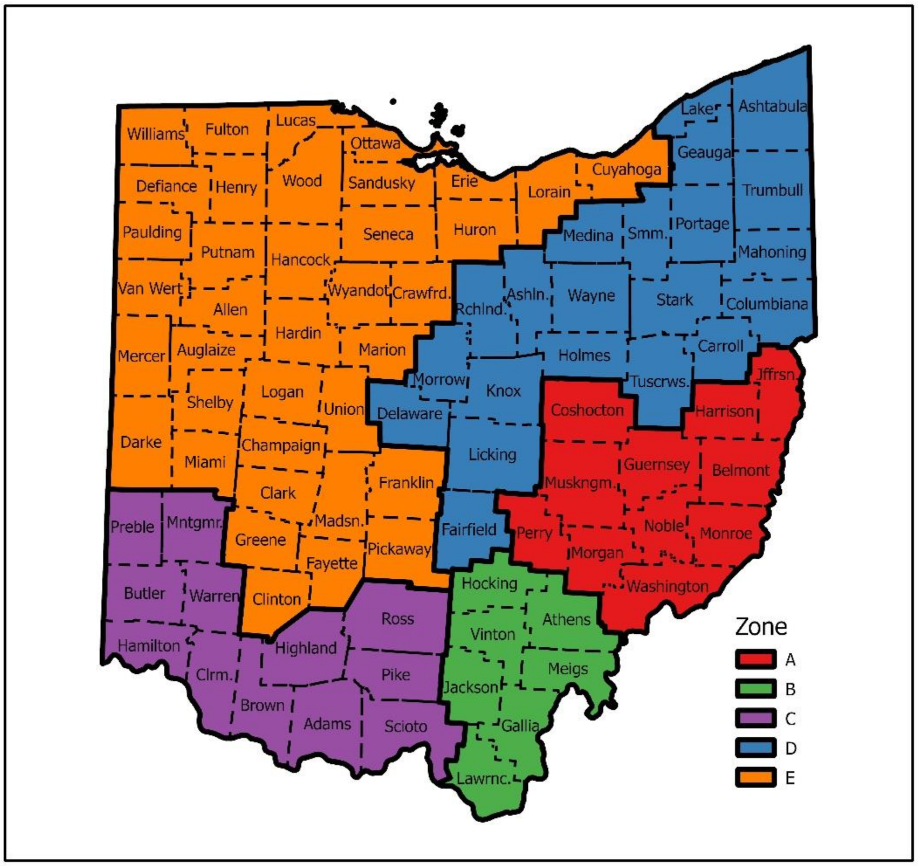


Figure 13. Ohio Bobcat Management Zones

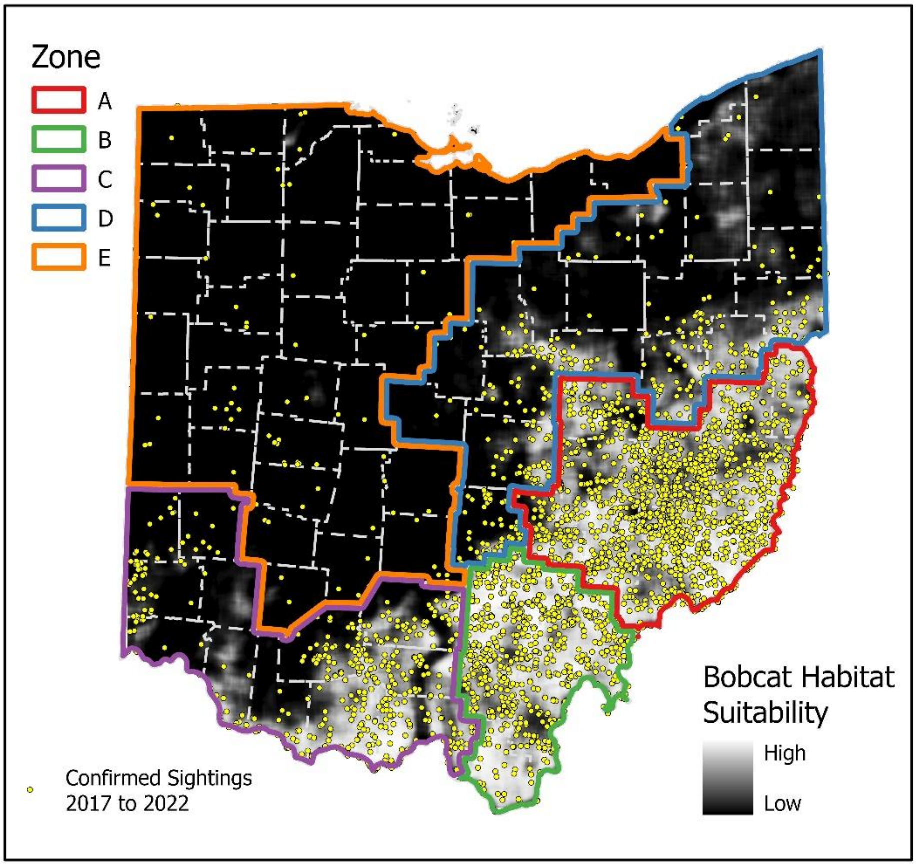


Figure 14. Ohio bobcat habitat suitability from Popescu et al. (2021) and confirmed bobcat sightings from 2017-2022 within Ohio bobcat management Zones.

IV. Ohio Bobcat Management Goal and Objectives

GOAL : Manage the Ohio bobcat population to sustain established populations at ecologically sound and socially acceptable levels and allow for continued expansion of the population into suitable habitat that is not yet fully occupied.

- Challenges
  - Differing opinions in public values of bobcats
  - Species is wide ranging and elusive, posing challenges to statewide monitoring/accurate estimates

Objective 1. Promote human-bobcat co-existence/tolerance

- Strategies
  - Use education and outreach tools to provide science-based information on bobcats in Ohio including:
    - Posters
    - Wild Ohio articles
    - News releases
    - Social media
    - Update existing webpages at wildohio.gov
    - Updates to existing mammal field guide
    - Produce educational materials/standard guidance on mitigation of nuisance situations
  - Permits and tracking
    - Develop/formalize guidelines for issuing nuisance removal permits for bobcats.
      - Before issuing a permit, staff should confirm that a bobcat is in fact the source of the conflict.
      - Before receiving a permit, landowners with the assistance/under the advisement of ODOW staff should make good-faith efforts to use mitigation strategies to prevent the conflict from continuing to occur.
      - Outside of core population areas (Zones A and B) require consultation with wildlife management staff before a permit may be issued.
    - Develop a standard method for tracking permits issued/filled annually.
    - Evaluate the number of permits issued/filled annually, and update guidelines as needed.
  - Rehabilitation and Release
    - Finalize and publish guidelines for rehabilitation and release of bobcats (see Appendix 2: Ohio Rehabilitation Minimum Standards (as of September 2023); Special Species Considerations for Bobcats).
    - Re-evaluate and update rehabilitation guidelines as needed.
    - Establish a statewide list of facilities available to take on rehabilitation of bobcats.

Objective 2. Conduct annual monitoring to assess changes in the distribution and relative abundance of the bobcat population over time.

- Strategies
    - Continue to collect sightings and compile information on annual sightings with an emphasis on using sightings to track expansion of the population/new areas with resident populations.
    - Continue to use the bowhunter survey for a standardized method of monitoring bobcats statewide.
    - Investigate other methods for standardized surveys (camera traps, etc.), and other monitoring methods (e.g. collection of roadkill) to supplement ongoing monitoring methods within core population areas (Eastern and Southern Zone) and areas of likely population expansion (Southwest and Northeast Zone).

Objective 3. Periodically update population information and management plan to reflect changes in the bobcat population and management concerns.

- Strategies
    - Update habitat suitability model every five years with updated sighting data.
    - Update density estimates for East and South Zones every five to 10 years.
        - As populations become established in other zones, produce population estimates for those portions of the state.
    - Use updated information to re-evaluate bobcat management zones and update the spatial population viability model at least every five to 10 years, or more often if a harvest season is implemented.
    - Update the bobcat management plan at least every five to 10 years.

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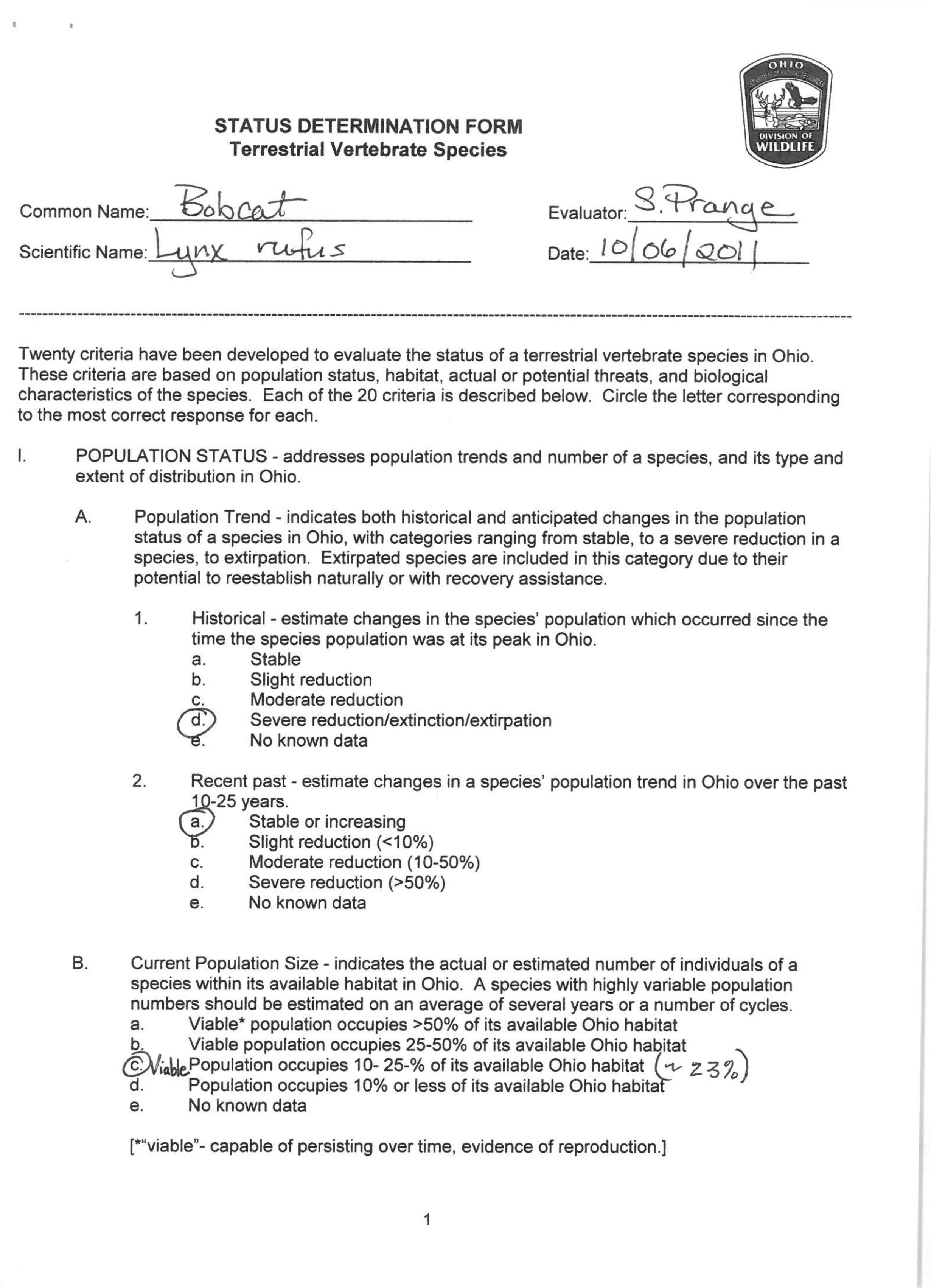
Appendix 1: Bobcat Downlisting and Delisting Documentation

Downlisting Documentation



OHIO DIVISION OF WILDLIFE

STATUS DETERMINATION FORM
Terrestrial Vertebrate Species

Common Name: Bobcat

Scientific Name: Lynx rufus

Evaluator: S. Prange

Date: 10/06/2011

Twenty criteria have been developed to evaluate the status of a terrestrial vertebrate species in Ohio. These criteria are based on population status, habitat, actual or potential threats, and biological characteristics of the species. Each of the 20 criteria is described below. Circle the letter corresponding to the most correct response for each.

I. POPULATION STATUS - addresses population trends and number of a species, and its type and extent of distribution in Ohio.

A. Population Trend - indicates both historical and anticipated changes in the population status of a species in Ohio, with categories ranging from stable, to a severe reduction in a species, to extirpation. Extirpated species are included in this category due to their potential to reestablish naturally or with recovery assistance.

1. Historical - estimate changes in the species' population which occurred since the time the species population was at its peak in Ohio.
   - a. Stable
   - b. Slight reduction
   - c. Moderate reduction
   - [✓ d.] Severe reduction/extinction/extirpation
   - e. No known data

2. Recent past - estimate changes in a species' population trend in Ohio over the past 10-25 years.
   - [✓ a.] Stable or increasing
   - b. Slight reduction (<10%)
   - c. Moderate reduction (10-50%)
   - d. Severe reduction (>50%)
   - e. No known data

B. Current Population Size - indicates the actual or estimated number of individuals of a species within its available habitat in Ohio. A species with highly variable population numbers should be estimated on an average of several years or a number of cycles.
- a. Viable* population occupies >50% of its available Ohio habitat
- b. Viable population occupies 25-50% of its available Ohio habitat
- [✓ c.] Viable Population occupies 10- 25-% of its available Ohio habitat (~ 23%)
- d. Population occupies 10% or less of its available Ohio habitat
- e. No known data

[*"viable"- capable of persisting over time, evidence of reproduction.]

C. Current Statewide Distribution - the number of Ohio counties in which the species occurs.
- a. >30 counties
- [✓ b.] 11 to 29 counties (24)
- c. 6 to 10 counties
- d. <5 counties
- e. No known data

D. Current Rangewide Occurrence - the occurrence of a species throughout its entire North American range based on the biology/life history of the species.
- [✓ a.] Common/Abundant throughout its range
- b. Designated as Threatened or Endangered by most Midwestern states
- c. Designated as a Federal Candidate Species or is threatened with extirpation from the Midwest states
- d. Designated as a Federally Endangered or Threatened Species
- e. No known data

E. Occurrence in Ohio - a description of the presence and distribution in Ohio in relation to rangewide occurrence.
- a. Not endemic (native) to Ohio
- b. Periphery of range is in Ohio
- c. Disjunct from main portion of it's US range; occurs in Ohio
- [✓ d.] Center of abundance is in Ohio
- e. A species with a very limited US range with most of its rangewide population occurring in Ohio

II. HABITAT - addresses the abundance and reduction of available habitat which limits a viable population of the species, as well as the stability of that habitat.

A. Abundance - indicate the amount of available habitat for a viable population of the species in Ohio.
- a. Abundant
- [✓ b.] Common
- c. Uncommon
- d. Rare
- e. No known data

B. Available Habitat Reduction - indicates the current availability of habitat limiting a viable population of the species compared to the availability of that habitat within its historical range in Ohio.
- a. No reduction
- b. Slight reduction (less than 10% lost)
- c. Moderate reduction (10% to 50% lost)
- [✓ d.] Severe reduction (more than 50% lost) – based on % forest cover lost since pre-settlement.
- e. No known data

The following dates should be used as the baseline period when the most habitat was available in Ohio:

1850	Riparian, Forest, Wetlands, Unique Habitats (caves, oak savannas, Lake Erie Islands, NE Boreal Community)
1930/1940	Grassland

III. THREATS - addresses actual or potential threats that occur naturally or are the result of human activity. Values range from none to severe in all categories.

A. Current Habitat Loss - the amount of habitat lost over the last 10 years.

[✓ a. Low]
b. Moderate
c. High
d. Severe
e. No known data

B. Potential for Habitat Recovery - the potential for habitat recovery.

a. High
b. Moderate
[✓ c. Low]
d. Nonrecoverable
e. No known data

C. Current Exploitation - Effect on the population by human-caused exploitation such as collection or harvest.

a. None
b. Compensatory
[✓ c. Unknown] ~ likely little, but some illegal harvest
d. Additive

D Human Disturbance - includes the effects of human disturbance other than collection or harvest (i.e, entering a mine while bats are hibernating).

a. None and none anticipated
[✓ b. Tolerable disturbance]
c. Moderate disturbance
d. Severe disturbance
e. No known data

E. Biological - includes natural factors which may adversely affect a species such as disease, competition, predation, or hybridization.

a. None
[✓ b. Low]
c. Moderate
d. Severe
e. No known data

F. Environmental Hazards - such as chemical contaminants or physical hazards that may affect a species or its habitat considering the natural sensitivity of a species.

a. None
[✓ b. Low]
c. Moderate
d. Severe
e. No known data

IV. BIOLOGICAL CHARACTERISTICS - addresses the ability and sensitivity of a species to respond within its environment.

A. Life History Specialization - indicates the ability of a species to adapt to changing environmental conditions.

1. Food Specialization - indicates the extent to which a species is limited by its specificity in food.
   - a. Not limiting, adaptable
   - [✓ b.] Somewhat limiting
   - c. Limiting
   - d. Highly limiting, very specialized
   - e. No known data

2. Reproductive Specialization - indicates the extent to which specific habitat, behavior, or essential breeding requirements limit the reproductive ability of a species.
   - a. Not limiting, adaptable
   - [✓ b.] Somewhat limiting
   - c. Limiting
   - d. Highly limiting, very specialized
   - e. No known data

3. Habitat Specialization - includes the extent to which a species is limited by specificity of habitat during its most critical life history stage.
   - a. Not limiting, adaptable
   - [✓ b.] Somewhat limiting
   - c. Limiting
   - d. Highly limiting, very specialized
   - e. No known data

4. Habitat Fragmentation - includes the sensitivity of a species to the loss of continuity of available habitat.
   - a. None
   - b. Low
   - [✓ c.] Moderate
   - d. Severe
   - e. No known data

B. Biotic Potential - Reproductive Ability - ability of the species to recover from serious declines in the population size.
- a. Females sexually mature at a young age and produce large numbers of offspring
- [✓ b.] Females sexually mature at a younger age and produce small numbers of offspring
- c. Females sexually mature at an older age and produce large numbers of offspring
- d. Females sexually mature at an older age and produce small numbers of offspring
- e. No known data

C. Dispersal - indicates the behavioral and physical ability of a species to move into unoccupied habitat or escape from adverse environmental conditions.
- a. Mobile, low site fidelity
- b. Non-mobile, large home range
- [✓ c.] Mobile, high site fidelity
- d. Non-mobile, small home range
- e. No known data

MEMORANDUM

Division of Wildlife
Wildlife Management & Research Group

To: Carolyn Caldwell

From: Suzie Prange, Ph.D.

Date: September 28, 2011

Subject: Bobcat, *Lynx rufus* Down-listing from State Endangered to State Threatened

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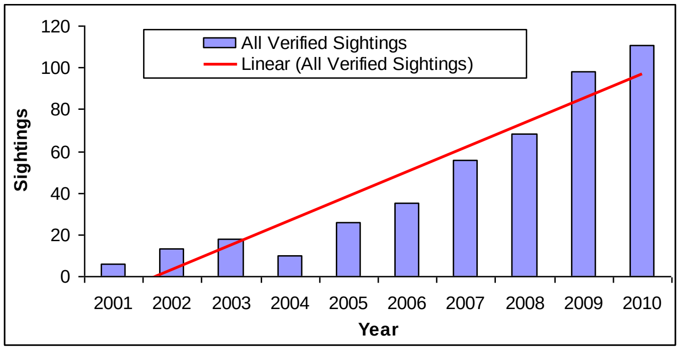
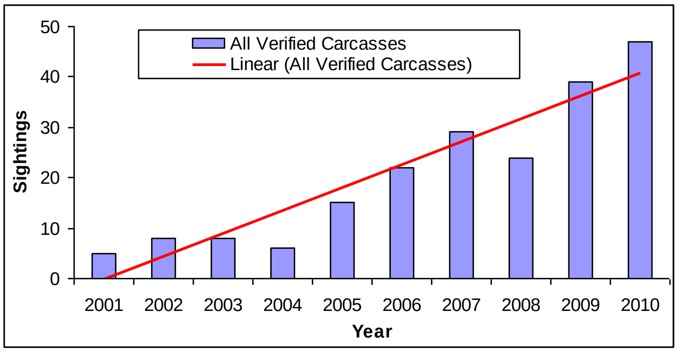
Bobcat Status

Camera and hair snare surveys for bobcats were conducted at 12 randomly selected sites in southeastern Ohio during 2008 to estimate occupancy. Bobcats were detected at 5 of these sites, and occupancy models revealed an estimated occupancy rate of 33%. Detection rates via camera surveys were also positively correlated with verified sightings within a 5-km radius (distance based on average home range size of male bobcats) of the camera site ($r^2 > 0.68$, $P < 0.001$). Consequently, verified sightings may serve as a range-wide index to bobcat distribution and relative abundance.



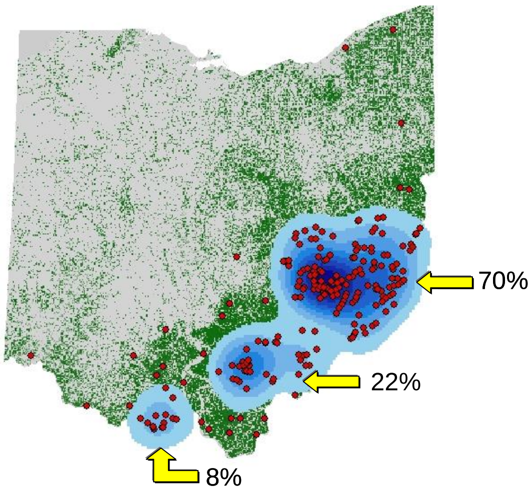
Verified sightings show a substantial and consistent increase in bobcat abundance during the past decade.

Some of this increase could be attributable to the increase in trail camera use and not actual bobcat abundance. However, using the number of carcasses collected only, we see a similar trend.



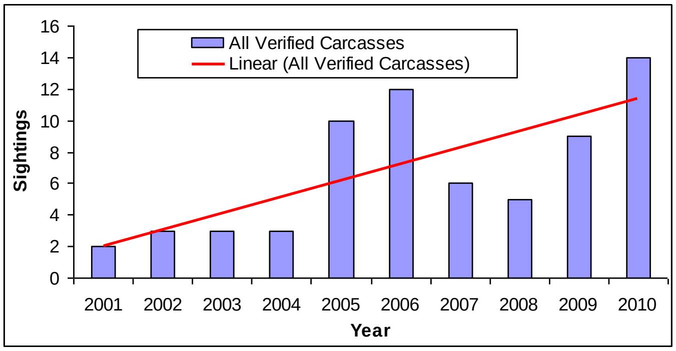
Problem of 2 populations:

Based on kernel density analyses of verified sightings, current bobcat range encompasses all or part of 24 southeastern counties. Initial reestablishment occurred almost simultaneously in 2 spatially distinct areas, and today, relative abundance is uneven and remains higher around these “eastern” (Noble County) and “southern” focal points (Vinton and Jackson counties). Since 1970, the eastern population increased more rapidly, and annually approximately 70% of sightings originate from about 20% of bobcat range. For example, of the 106 verified reports in 2010, 21 (20%) were from Noble County, and 71 (67%) were reported within a one-county radius of Noble County.



Based on microsatellite DNA data, the eastern and southern populations are genetically distinct. Furthermore, the Noble County centered population is being maintained by breeding, whereas bobcats in the remainder of the state (i.e., within approximately 80% of available habitat) are being maintained through immigration from the surrounding populations, including those in West Virginia and Kentucky (Anderson et al., in prep.). As such, the southern population can be considered a sink, or a population that is currently incapable of supporting itself should immigration cease.

Regardless, the southern population is exhibiting an increasing trend, although not consistent year to year.



Population size

The overall number of bobcats in Ohio is likely <1,000 individuals.

My best population estimate is based on the number of roadkills and the proportion of population mortality due to vehicle-related fatalities in nearby states, proving a 2010 estimate of 450 individuals. However, this assumes that I receive reports on every bobcat hit on the roads, which is unreasonable. If I assume that 50% are reported, the estimate doubles to 900. In any case, this is not an extremely reliable technique on which to base an estimate of population size, but it is all the field data I have at present.

Population estimates based on genetics of Ohio bobcats, however, support the "roadkill" population estimate. Using 2 different estimators Anderson et al. (in prep.) calculated population size to be between 250-1,100. The wide range is due to the fact that one estimator was conservative and the other liberal. Anderson et al. interpreted this as follows, "Preliminary findings suggest that the census population size in each Ohio population is likely in the 100s of individuals or less."

This fall/winter I will be placing GPS collars on bobcats in both populations. Detailed location data together with camera detection data will allow me to make a robust estimate of bobcat population size.

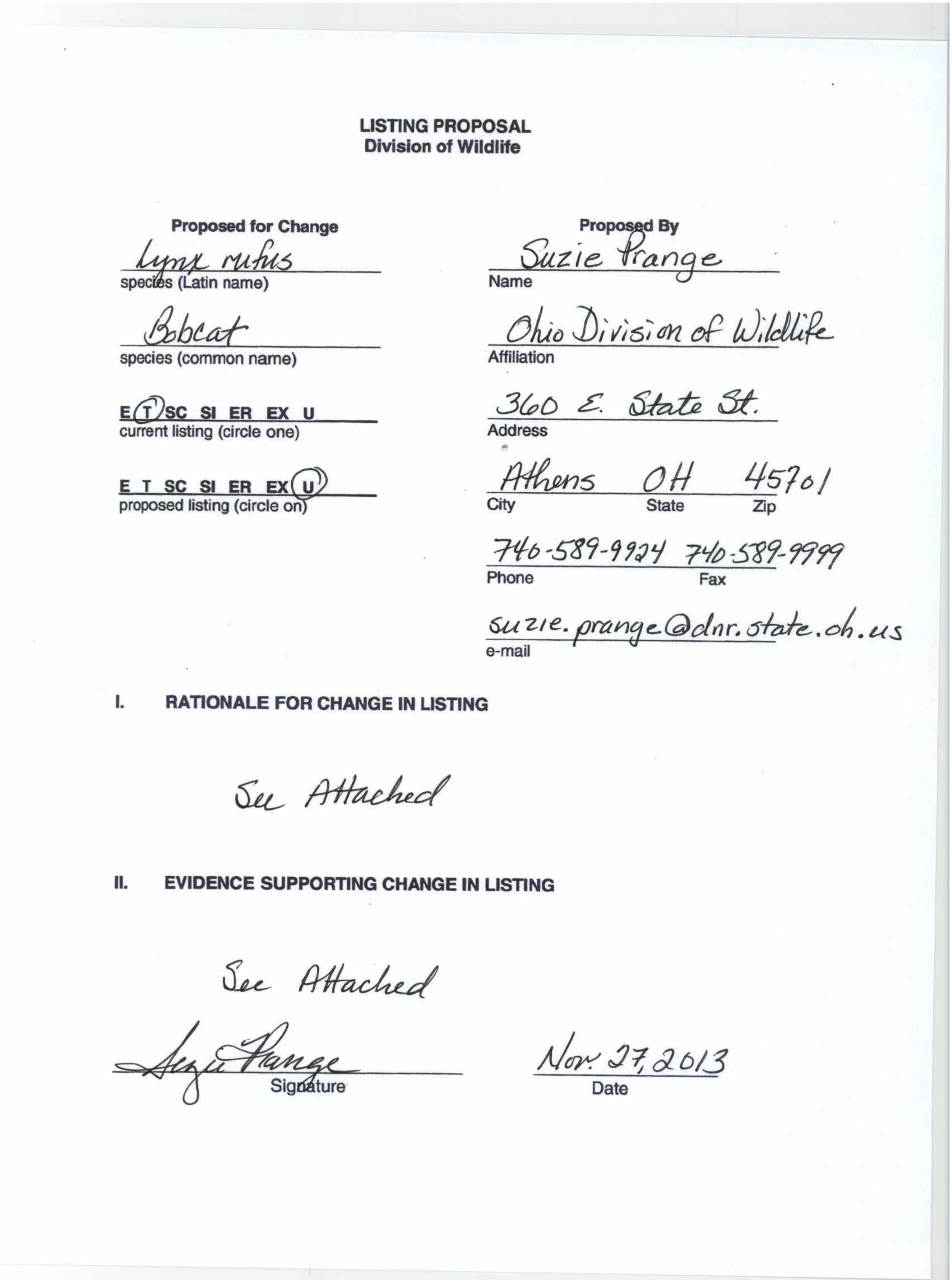
I am also currently working on developing an effective way to annually survey bobcats range wide. Track stations are showing good results, but are labor intensive (although only over a very short period – 1 to 2 weeks). I will test the efficacy of snow track surveys during this and the following winter.

In summary:

Bobcats are not currently threatened with extirpation from the state and are increasing and doing well in eastern Ohio. Bobcats in southern Ohio are increasing, but still can be considered a sink population. The best scientific estimates of population size currently available tell us there are less than 1,000 individuals statewide.

My recommendation is to downlist the bobcat from state endangered to state threatened. In the coming years, we will continue to conduct research on this species to generate a more robust population estimate, attempt to better understand why the southern population is not growing as well as the eastern one, and develop and implement an annual survey.

Delisting Documentation



LISTING PROPOSAL
Division of Wildlife

Proposed for Change

Lynx rufus
species (Latin name)

Bobcat
species (common name)

E [✓ T] SC SI ER EX U
current listing (circle one)

E T SC SI ER EX [✓ U]
proposed listing (circle on)

Proposed By

Suzie Prange
Name

Ohio Division of Wildlife
Affiliation

360 E. State St.
Address

Athens OH 45701
City State Zip

740-589-9924 740-589-9999
Phone Fax

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e-mail

I. RATIONALE FOR CHANGE IN LISTING

See Attached

II. EVIDENCE SUPPORTING CHANGE IN LISTING

See Attached

Suzie Prange
Signature

Nov. 27, 2013
Date

OHIO
DIVISION OF WILDLIFE

STATUS DETERMINATION FORM
Terrestrial Vertebrate Species

Common Name: Bobcat
Scientific Name: Lynx rufus
Evaluator: S. Prange
Date: 11/27/2013

Twenty criteria have been developed to evaluate the status of a terrestrial vertebrate species in Ohio. These criteria are based on population status, habitat, actual or potential threats, and biological characteristics of the species. Each of the 20 criteria is described below. Circle the letter corresponding to the most correct response for each.

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1. Historical - estimate changes in the species' population which occurred since the time the species population was at its peak in Ohio.
   - a. Stable
   - b. Slight reduction
   - c. Moderate reduction
   - [✓ d.] Severe reduction/extinction/extirpation
   - e. No known data

2. Recent past - estimate changes in a species' population trend in Ohio over the past 10-25 years.
   - [✓ a.] Stable or increasing
   - b. Slight reduction (<10%)
   - c. Moderate reduction (10-50%)
   - d. Severe reduction (>50%)
   - e. No known data

B. Current Population Size - indicates the actual or estimated number of individuals of a species within its available habitat in Ohio. A species with highly variable population numbers should be estimated on an average of several years or a number of cycles.
   - a. Viable* population occupies >50% of its available Ohio habitat
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[*"viable"- capable of persisting over time, evidence of reproduction.]

C. Current Statewide Distribution - the number of Ohio counties in which the species occurs.

- a. >30 counties
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D. Current Rangewide Occurrence - the occurrence of a species throughout its entire North American range based on the biology/life history of the species.

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II. HABITAT - addresses the abundance and reduction of available habitat which limits a viable population of the species, as well as the stability of that habitat.

A. Abundance - indicate the amount of available habitat for a viable population of the species in Ohio.

- a Abundant
- [✓ b.] Common
- c. Uncommon
- d. Rare
- e. No known data

B. Available Habitat Reduction - indicates the current availability of habitat limiting a viable population of the species compared to the availability of that habitat within its historical range in Ohio.

- a. No reduction
- b. Slight reduction (less than 10% lost)
- c. Moderate reduction (10% to 50% lost)
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The following dates should be used as the baseline period when the most habitat was available in Ohio:

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1930/1940	Grassland

III. THREATS - addresses actual or potential threats that occur naturally or are the result of human activity. Values range from none to severe in all categories.

A. Current Habitat Loss - the amount of habitat lost over the last 10 years.
    [✓ a.] Low
    b. Moderate
    c. High
    d. Severe
    e. No known data

B. Potential for Habitat Recovery - the potential for habitat recovery.
    a. High
    b. Moderate
    [✓ c.] Low
    d. Nonrecoverable
    e. No known data

C. Current Exploitation - Effect on the population by human-caused exploitation such as collection or harvest.
    [✓ a.] None
    b. Compensatory
    c. Unknown
    d. Additive

D Human Disturbance - includes the effects of human disturbance other than collection or harvest (i.e, entering a mine while bats are hibernating).
    [✓ a.] None and none anticipated
    b. Tolerable disturbance
    c. Moderate disturbance
    d. Severe disturbance
    e. No known data

E. Biological - includes natural factors which may adversely affect a species such as disease, competition, predation, or hybridization.
    a. None
    [✓ b.] Low
    c. Moderate
    d. Severe
    e. No known data

F. Environmental Hazards - such as chemical contaminants or physical hazards that may affect a species or its habitat considering the natural sensitivity of a species.
    a. None
    [✓ b.] Low
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    d. Severe
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IV. BIOLOGICAL CHARACTERISTICS - addresses the ability and sensitivity of a species to respond within its environment.

A. Life History Specialization - indicates the ability of a species to adapt to changing environmental conditions.

1. Food Specialization - indicates the extent to which a species is limited by its specificity in food.
    - a. Not limiting, adaptable
    - [✓ b. Somewhat limiting]
    - c. Limiting
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2. Reproductive Specialization - indicates the extent to which specific habitat, behavior, or essential breeding requirements limit the reproductive ability of a species.
    - a. Not limiting, adaptable
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    - c. Limiting
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    - e. No known data

3. Habitat Specialization - includes the extent to which a species is limited by specificity of habitat during its most critical life history stage.
    - a. Not limiting, adaptable
    - [✓ b. Somewhat limiting]
    - c. Limiting
    - d. Highly limiting, very specialized
    - e. No known data

4. Habitat Fragmentation - includes the sensitivity of a species to the loss of continuity of available habitat.
    - a. None
    - [✓ b. Low]
    - c. Moderate
    - d. Severe
    - e. No known data

B. Biotic Potential - Reproductive Ability - ability of the species to recover from serious declines in the population size.
- a. Females sexually mature at a young age and produce large numbers of offspring
- [✓ b. Females sexually mature at a younger age and produce small numbers of offspring]
- c. Females sexually mature at an older age and produce large numbers of offspring
- d. Females sexually mature at an older age and produce small numbers of offspring
- e. No known data

C. Dispersal - indicates the behavioral and physical ability of a species to move into unoccupied habitat or escape from adverse environmental conditions.
- [✓ a. Mobile, low site fidelity]
- b. Non-mobile, large home range
- c. Mobile, high site fidelity
- d. Non-mobile, small home range
- e. No known data

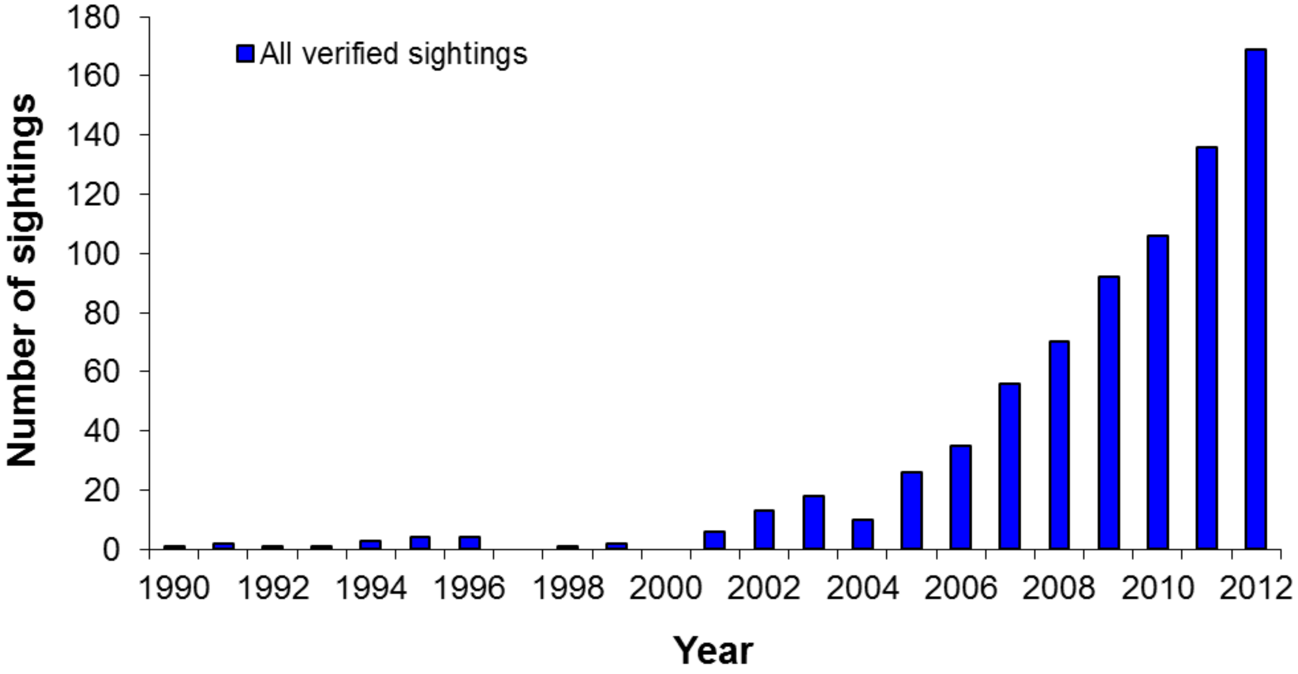
RATIONALE

Bobcats are not currently threatened with extirpation from the state and are increasing and doing well in southeastern Ohio, where the majority of available habitat exists. Since 1970, there have been 796 verified reports of bobcats in Ohio, of which the great majority have occurred since 2000 (n = 768; 96%). Overall, verified sightings have increased steadily over the past decade; there were 169 verified bobcat reports in 2012 compared to 136 in 2011. Based on field statistics, as well as genetic analyses, bobcat population size is estimated at about 1,000 individuals. The population has recovered to the point where incidental captures by trappers are common, nuisance issues involving poultry depredation have been documented, and orphaned young have been reported. There is no foreseeable threat that would inhibit the bobcat population from continuing to grow until they completely exploit available habitat in Ohio. As such, delisting them should not inhibit bobcat population growth, but will allow the Division of Wildlife to deal with issues arising from a quickly growing bobcat population.

EVIDENCE SUPPORTING CHANGE IN LISTING

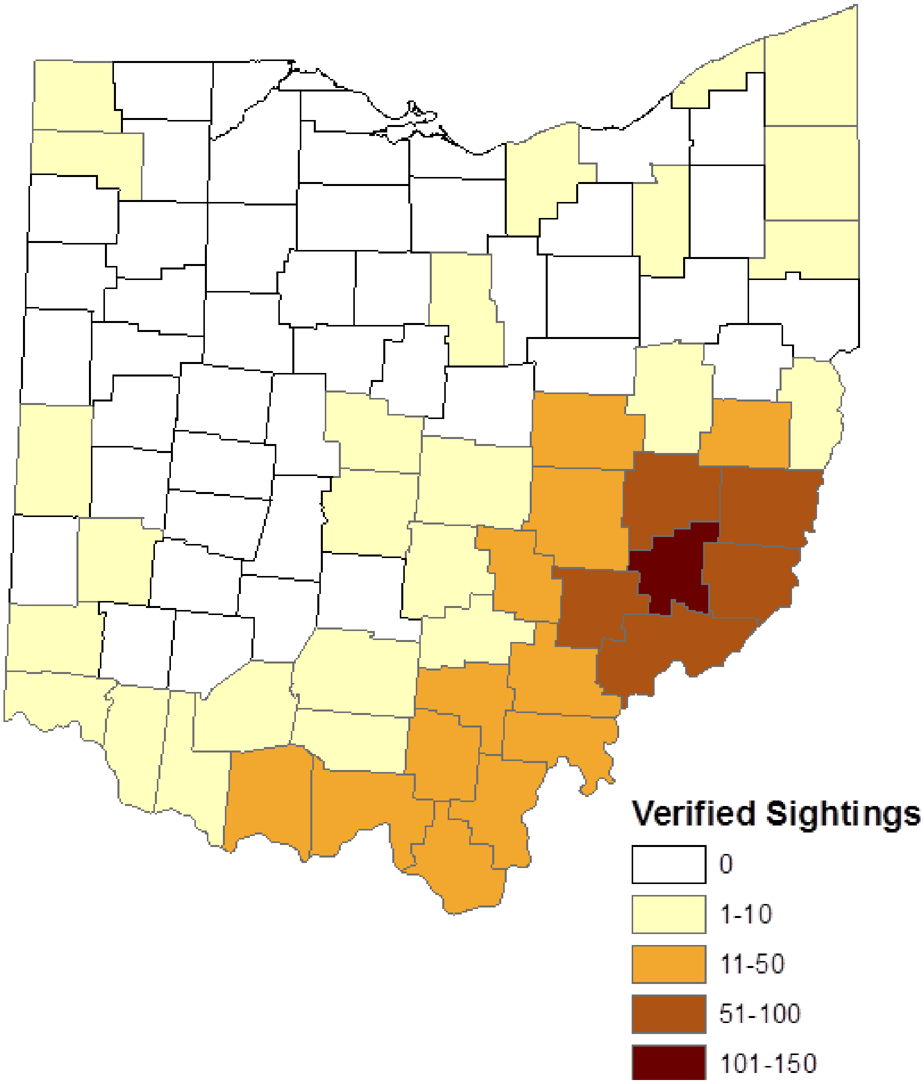
Camera and hair snare surveys for bobcats were conducted at 12 randomly selected sites in southeastern Ohio during 2008 to estimate occupancy. Bobcats were detected at 5 of these sites, and occupancy models revealed an estimated occupancy rate of 33%. Detection rates via camera surveys were also positively correlated with verified sightings within a 5-km radius (distance based on average home range size of male bobcats) of the camera site ($r^2 > 0.68$, $P < 0.001$). Consequently, verified sightings may serve as a range-wide index to bobcat distribution and relative abundance. Occupancy of available habitat, which encompasses the Alleghany Plateau Ecoregion in southeastern Ohio, has likely increased since the 2008 study as the population based on verified sightings has increased. Verified sightings show a substantial and consistent increase in bobcat abundance during the past decade.

NUMBER OF VERIFIED BOBCAT SIGHTINGS BY YEAR



Verified bobcat reports were documented in 31 counties during 2012 and in 43 counties since 1970. Bobcat sightings during 2012 continue to be highly aggregated. Of the 169 verified reports, 23 (14%) were from Noble County, and 105 (62%) were reported within a 1-county radius of Noble County.

NUMBER AND DISTRIBUTION OF VERIFIED BOBCAT SIGHTINGS FROM 1970 - 2012



This eastern area likely contains prime bobcat habitat. There are, however, no barriers (e.g., major roads, cities, waterways) that would keep bobcats in the eastern cluster from expanding into the remainder of available habitat to the south. When the prime habitat is fully saturated, considerable bobcat population growth in the southern portion of the Alleghany Plateau is expected.

Initial results of a radiotelemetry study in Noble and Vinton counties confirms that resource availability is greater in Noble County as bobcat home ranges (the area needed to satisfy resource needs) are smaller. Nonetheless, all captured bobcats in both the eastern and southern study areas have been in good condition and have been negative for exposure to common felid diseases with low parasite loads.

Appendix 2: Ohio Rehabilitation Minimum Standards (as of September 2023); Special Species Considerations for Bobcats

SPECIAL SPECIES CONSIDERATIONS (source ODW)
Special species authorizations are limited due to the geographic need, education, training, and experience. Authorization of bobcat or fawn is for the permitted facility only and excludes subpermit holders. Prior to accepting any bobcats, all parties need to educate callers on the biology and ensure any orphan is indeed orphaned before it is removed from the wild.

1. **Bobcat**

The Chief may authorize Category II rehabilitators the option to rehabilitate orphaned bobcats who have both an approved facility and inspection. Rehabilitation of an adult bobcat may be determined after consultation with the Division of Wildlife.

Procedure
Licensed wildlife rehabilitators may accept bobcats that are considered orphaned with certainty, for immediate transfer to an authorized Category II rehabilitation facility. Within 24 hours of receiving a bobcat, the rehabilitator must contact the district wildlife management supervisor.

Authorized Category II rehabilitators will adhere to the following:

Treatment
- Stimulate for fecal/urination activity
- Check and treat minor wounds
- Maintain body temperature
- If immobilization drugs are used, the animal must be tagged upon release.

Caging Requirements
- No exposure to human sights, smells and sounds.
- A double-door entryway on the bobcat enclosure is mandatory and secured with a lock.
- Ability to climb and perform normal bobcat behaviors
- Solid or slatted walls on the bottom half of the enclosure to provide a visual barrier
- Substrate must consist of natural earth, gravel, grass, or tan bark
- Caging and substrate must be escape-proof (completely contained, predator proofing floor)
- Provide branches/logs for climbing, and platforms for resting above cage floor
- Provide 2 water sources
- Provide other furnishings such as plastic barrels, hollow logs, or cardboard boxes for hiding
- Cage size should meet the minimum standards outlined below:

Infant Care W x L X H	Nursing/Pre-weaned W x L X H	Juvenile Outside W x L X H
10 Gallon	3 ft x 3 ft x 3 ft	10 ft x 10 ft x 8 ft

Release

- Collaboration with Wildlife Management team is required prior to release. Rehabilitation facilities in urban areas may release in adjacent counties.
- Ability to live hunt
- A minimum of 6 months of age

Criteria Requiring Euthanasia

- Significant injury (broken limb)
- Habituated to humans
- Euthanasia techniques shall comply with AVMA standards based on location and circumstances