

Canada Lynx-bobcat (*Lynx canadensis* × *L. rufus*) Hybrids at the Southern Periphery of Lynx range in Maine, Minnesota and New Brunswick

ABSTRACT.—Hybridization between federally threatened Canada lynx (*Lynx canadensis*) and bobcat (*L. rufus*) was recently documented in the United States, but little is known regarding physical characteristics of hybrids compared to parent species. We report on the morphology and physical characteristics of five of seven Canada lynx-bobcat hybrids detected near the southern extent of the lynx's geographic range in Maine, Minnesota and New Brunswick. Hybrids displayed a range of physical characteristics, including features common to both lynx and bobcat, or that were intermediate in character. Observation of an adult female hybrid with three kittens, as well as placental scars in the reproductive tract of a second animal, suggest that hybrids may be reproducing successfully. We recommend that careful measurement, recording and photographing of key characteristics as well as genetic analysis of suspected lynx-bobcat hybrids be priorities for natural resource agencies where hybridization between these species may occur.

INTRODUCTION

Hybridization between rare species and those that are more common has been described as affecting the recovery of plants, birds, fish and mammals (*see* Rhymer and Simberloff, 1996; Allendorf *et al.*, 2001 for reviews). Prior to the intensive study of lynx that has occurred since their listing as threatened under the ESA in Mar. 2000 (U.S. Department of the Interior, 2000), hybridization between wild populations of Canada lynx and sympatric populations of bobcat (*Lynx rufus*) was unrecognized. However, such hybridization was documented recently in Minnesota (Schwartz *et al.*, 2004), Maine and New Brunswick (Libby, 2004), each at the southern periphery of the geographic range of lynx. Schwartz *et al.* (2004) suggest that hybridization may be an overlooked element in the recovery of threatened populations of Canada lynx (*L. canadensis*).

Morphologically, Canada lynx are differentiated from bobcats by their longer ear tufts (>2.5 cm), completely black-tipped tail, large, oversized, completely furred feet and grayer, less spotted pelage (Anderson and Lovallo, 2003). Bobcats have smaller feet, less conspicuous ear tufts (<2.5 cm) and often have heavily spotted pelage (Larivière and Walton, 1997; Nowak, 1999). Canada lynx typically inhabit areas that receive large amounts of snowfall where their large, furred feet and low foot-loading contribute to a competitive advantage in capturing their primary prey, snowshoe hare (*Lepus americanus*) (Buskirk *et al.*, 2000). Bobcats, with >3× the foot-loading of lynx (Buskirk *et al.*, 2000), have evolved to occupy numerous habitat types with little to no snowfall and prey on a more diverse diet (Nowak, 1999).

In this study, we report on the characteristics of confirmed Canada lynx-bobcat hybrids in comparison to both parent species and present the first evidence suggesting that F1 generation hybrids have successfully reproduced. Our objective is to describe physical characteristics and morphology of lynx-bobcat hybrids to assist in future identification of individuals.

METHODS

Observation and sampling for lynx-bobcat hybrids was opportunistic; the public or staff biologists alerted state, provincial or federal agencies when a felid was observed that appeared “non-typical” or was difficult to identify as either a bobcat or lynx. Measurements and recording of data was completed by several agencies without prior coordination for a standardized protocol; therefore, measurements recorded on live animals and carcasses varied. Tissue and/or hair samples from felids suspected of being hybrids were sent to a genetics laboratory for processing [U.S. Department of Agriculture (USDA) Forest Service Rocky Mountain Research Station's Wildlife Ecology Unit located in Missoula, Montana]. All samples were processed using the hybrid assay method developed and described by Schwartz *et al.* (2004) and included three animals from Minnesota documented by Schwartz *et al.* (2004). The hybrid assay was based on comparing non-overlapping allele frequencies at two loci for bobcats and lynx, for which F1 hybrids display alleles from both distributions.

RESULTS

Seven hybrid animals (5F:2M) were detected in two states and one province (Maine, $n = 2$; Minnesota, $n = 3$; New Brunswick, $n = 2$), collected from 1986–2003. In northern Maine, fur-trappers captured two female cats with foothold traps in Nov. 1998 and 2002 in Somerset and Piscataquis Counties, respectively. The 1998 animal was anesthetized and fitted with a radio-collar by biologists from Maine Department of Inland Fisheries and Wildlife (MDIFW) and released at the trap-site. The 2002 animal was observed with three kittens for several minutes; one kitten perched in a nearby quaking aspen (*Populus tremuloides*) tree and two on the ground (pers. obs., J. Homyack). The trapper harvested this cat and MDIFW was able to retain the animal for study, including collection of genetic samples.

Three bobcat-lynx hybrids (1F:2M) were detected in Minnesota from Feb.–Dec. 2002. On 22 Feb. 2002, a hair sample determined to be from a male hybrid was collected from a resting bed in Cook County, Minnesota (pers. obs., S. Loch). A road-killed female animal near Knife River on Highway 61 in St. Louis County, Minnesota was collected by S. Loch on 26 Nov. 2002. Finally, a fur-trapper captured a male hybrid in a conibear set east of Marcel in Itasca County, Minnesota in Dec. 2002. The Knife River specimen and the felid from Marcel, Minnesota had similar pelage and physical characteristics (pers. obs., S. Loch), atypical of either lynx or bobcat; the size of the paws and the coloration on the ventral surface of the tail tip were intermediate between lynx and bobcat. Lastly, a fur-trapper captured a 11.4 kg hybrid in Victoria County in northwestern New Brunswick on 03 Dec. 2003. The skin and skeleton of this animal were deposited in the collection of the New Brunswick Museum (NBM # 6006). This cat was an adult female with two placental scars in her reproductive tract (Libby, 2004). Following the detection of hybrids in New Brunswick and elsewhere, the New Brunswick Department of Natural Resources sent a dry tissue sample from a New Brunswick Museum skeletal specimen (NBM # 4969) to the Rocky Mountain Research Station for analysis. The animal, a female, was harvested at Freeze Lakes, Northumberland County, in northeastern New Brunswick on 12 Nov. 1986. It was identified as a lynx at capture but the trapper reported that it had atypical pelage characteristics. Genetic analysis determined it to be a hybrid.

All seven hybrids were determined, via genetic analysis, to have been parented by male bobcats and female Canada lynx (Schwartz *et al.*, 2004). Of five animals examined for external morphology (one Minnesota hybrid was detected by collecting hair from day bed and the only skeleton that was available was from one New Brunswick hybrid), all had tails with black distal tips, which is characteristic of lynx, but each also had white hairs dispersed through the ventral surface of the tail (Table 1, Fig. 1). Both hybrids detected in Maine were described by biologists familiar with the parent species as having “bobcat-like” paws, and the hind feet of the 1998 and 2002 animals measured 17.5 cm and 20.0 cm respectively, smaller than the range of 29 measured lynx (21.3–25.0 cm) from northern Maine (MDIFW, unpubl. data). The paws of the two Minnesota hybrids examined appeared intermediate in size; significantly larger than bobcats but smaller and less furred than lynx. The 2003 incidentally trapped specimen from New Brunswick, like the Minnesota specimens, had paws that were intermediate in character. Hind foot length in this animal was 18.7 cm, close to the 18.5 cm average for bobcat cited by Peterson (1966). Peterson (1966) reported average hind foot length in eastern Canadian lynx as significantly larger (24.0 cm). Pelage color on the under-feet of the New Brunswick hybrids were dark and match that of bobcat hides in the NBM collection. However, the distance of about 6.0 cm across the hind feet was nearly twice that of typical bobcats; toe pads were largely furred, approaching those of lynx. Lengths of ear tufts from all hybrids examined from Maine (4.0/3.5 cm, 3.8/3.8 cm), Minnesota (3.0/3.7 cm, 3.5/3.8 cm) and New Brunswick (3.9 cm) were within the range reported for Canada lynx (Anderson and Lovallo, 2003). Hybrid pelts, with at least some distinct spots, generally fit the profile of bobcats. Specimens from Maine and New Brunswick had reddish fur, a description also commonly applied to bobcats.

DISCUSSION

Carnivores at low densities and species near the geographic extent of their range have been predicted to have a high probability of hybridization (Brownlow, 1996; Seehausen, 2004). As advances in molecular analyses lead to genetic study of greater numbers of taxa, hybridization may be found to be a more common phenomenon than previously considered (Jones *et al.*, 1995; Brownlow, 1996; Rhymer and Simberloff, 1996). Despite these suggestions, naturally occurring hybridization between bobcats and Canada lynx in North America was not documented prior to publication of Schwartz *et al.* (2004).

TABLE 1.—Physical characteristics of five Canada lynx (*Lynx canadensis*) – bobcat (*L. rufus*) hybrids collected from 1986–2003 in Maine and Minnesota, USA and New Brunswick, Canada compared to published estimates for diagnostic characters of parent species

| | Diagnostic characters ^a | | | |
|--------------------------------|------------------------------------|--------------------------------|--|---|
| | Ear tuft length | Tail coloration | Hind feet | Pelage |
| Bobcats | <2.5 cm long | White hairs on ventral surface | Smaller, less fur males = 17.0 cm, females = 15.5 cm | Distinct spots, reddish |
| Canada lynx | >2.5 cm long | Tip completely black | Heavily furred in winter, 20.3–25.0 cm long | Gray, few spots |
| 1998 Maine hybrid ^b | 4.0/3.5 cm | A few white hairs interspersed | 17.5 cm long | Reddish brown, few spots on ventral surface |
| 2002 Maine hybrid ^b | 3.8/3.8 cm | A few white hairs interspersed | 20.0 cm long | Reddish brown, some spotting present |
| All Hybrids (n = 5) | 5 lynx-like | 5 intermediate in character | 5 intermediate in character | At least 3 with bobcat-like spots |

^a Ear tuft lengths, tail coloration and pelage reported by Anderson and Lovallo (2003). Hind foot lengths reported for bobcats by Larivière and Walton (1997) and for lynx by Tumilson (1987)

^b Individual measurements provided for those hybrids with most complete morphology



FIG. 1.—All Canada lynx-bobcat hybrid (*Lynx canadensis* × *L. rufus*) carcasses examined had tails with black distal tips, which is characteristic of lynx, but also had numerous white hairs dispersed through the ventral surface of the tail

Based on our experiences, lynx-bobcat hybrids may be difficult to identify visually because there is a range of physical traits that occur and hybrids may have features common to both lynx and bobcats (Table 1). Therefore, hybrids may be confused with either parent species in the field, even by experienced biologists. Given the number of hybrid individuals documented after capture (5 of 7), additional hybrids likely are being harvested by fur-trappers, but are not being recognized or reported by agency personnel, trappers or biologists.

Previously, it was not known whether Canada lynx-bobcats hybrids could successfully produce offspring (Schwartz *et al.*, 2004); however, through both direct observation of three kittens with a known female hybrid in Maine and placental scars documented in a New Brunswick female, we present evidence suggesting that first generation hybrids produced in Maine and possibly New Brunswick are fertile. Thus, bobcats may not only affect rare populations of Canada lynx via exploitative or interference competition (Buskirk *et al.*, 2000), but also through introgression. Schwartz *et al.* (2004) suggest that if successful reproduction of female hybrids is common, then hybrid swarms could decrease the extent of pure lynx at the southern periphery of the species range.

Allendorf *et al.* (2004) recommended that management decisions regarding hybridization be based on several criteria, including the amount of evolutionary divergence between taxa, the geographical extent of introgression, and the number of extant, non-hybridizing populations. However, until additional research is conducted describing these criteria for Canada lynx-bobcat hybrids, the extent of the threat to rare populations in southeastern Canada and the contiguous United States is unclear. Further, the length of time that hybridization between Canada lynx and bobcats has been occurring is unknown; however, the documentation of a 1986 hybrid from New Brunswick suggests the information presented here may be more than a recent, isolated phenomenon.

We conclude by recommending that distinguishing characteristics of hybrids should be carefully measured and recorded by field biologists and managers. The ear tuft length, paw dimensions and tail length and coloration all should be recorded and photographs of the underside of the tail, feet and pelage may aid future research. Where possible, skulls should be retained. Identification of hybrids using solely morphological characters provides less information and is less reliable than molecular analysis (Allendorf *et al.*, 2004); therefore, tissue samples from lynx and suspected hybrids should be collected and analyzed. Within the United States, there are no specific regulations covering hybridization in the wild between a species listed under the ESA and a more common species not legally protected by the ESA. Thus, in most instances, it is unclear who may possess carcasses, skeletons, skulls, pelts, etc., of bobcat-lynx hybrids; we suggest that state, provincial or federal agencies make all attempts possible to acquire known hybrid individuals for future study, and house specimens in museums where they will be accessible to future researchers.

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