

Note

Behavioural interactions among Canada Lynx (*Lynx canadensis*) during pre-estrous

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Abstract

Information is lacking on the behaviour of free-roaming Canada Lynx (*Lynx canadensis*) during the breeding season, likely because they are rarely observed in the wild. Other wild solitary felid males compete with each other to mate with promiscuous females. However, the behavioural context or sequence of this competition among wild male Canada Lynx remains unreported. We describe the behaviour of three adult wild lynx during the breeding season. We observed the first two lynx together; an adult male and an inferred adult female remained together non agonistically for nearly 2 h before they were interrupted by another adult male. Our observation of interaction between the two males includes agonistic behaviours, vocalizations, scent marking, fighting, and a long-distance (1.7-km) expulsion of the intruding male lynx by the first male. These observations add to the limited information available on the social ecology of lynx during the breeding season.

Key words: Alaska; Canada Lynx; *Lynx canadensis*; fighting; mating behaviour; scent marking; territoriality; vocalizations

There are few published observations of breeding and agonistic behaviour among wild Canada Lynx (*Lynx canadensis*) during the breeding season (Mowat *et al.* 2000; O'Donoghue *et al.* 2010; Stanton *et al.* 2015; Andrews *et al.* 2018; Lavoie *et al.* 2019). Most information on Canada Lynx mating behaviour comes from observations of captive animals (e.g., Anderson and Lovallo 2003; Stanton *et al.* 2015). The mating season of lynx in interior Alaska is from late March through early April (Nava 1970), and in British Columbia it apparently peaks during the second half of March (Crowley *et al.* 2013). In Alberta (Nellis *et al.* 1972) and elsewhere, it may last into May. The lynx estrus cycle lasts a month; captive female lynx are apparently in estrus only 3–5 days, and wild female lynx may be presumed to mate with only one male (Sunquist and Sunquist 2002). However, perhaps like Eurasian Lynx (*Lynx lynx*), female Canada Lynx may be promiscuous breeders and males may search widely outside their usual home ranges for receptive females and defend them during the brief breeding period (Erofeeva and Naidenko 2012).

There is no published, direct, and visually supported information on agonistic, aggressive, or fighting behaviour among wild Canada Lynx. We found

four videos of vocalizing or fighting lynx posted on the internet, but they lacked behavioural context (MacKay 2014; Lewis 2018; Wiebe 2018; Wadleigh 2020). The videos were reportedly made on 1 April (Weibe 2018) and 18 May (Lewis 2018), months perhaps associated with the mating season, and on 29 May (Wadleigh 2019) and 28 October (MacKay 2014). Here, we summarize our observations of three wild adult Canada Lynx during the mating season in Alaska; detailed observations are included in Appendix S1. We took videos of segments of the interaction we observed: Video S1 and S2.

For 3 h on 14 March 2020, we opportunistically observed a wild adult lynx of unknown sex and an adult male lynx, later interrupted by another adult male, interact during the breeding season. Our observations, which were from a vehicle, occurred within the Skilak Wildlife Recreation Area (SWRA), Kenai National Wildlife Refuge, Alaska (60.44991°N, 150.2319°W), an area closed to the hunting and trapping of carnivores to increase wildlife viewing opportunities. Our observations took place along the Skilak Lake Loop Road traversing the SWRA, near a road pullout (known as Skilak Lake Overlook), which we refer to as site A.

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The 73-year-old forest in the area is dominated by Black Spruce (*Picea mariana* (Miller) Britton, Sterns & Poggenburgh), Alaska Birch (*Betula neoalaskana* Sargent), and Trembling Aspen (*Populus tremuloides* Michaux). Much of the surrounding habitat was destroyed by the 2019 Swan Lake Fire, leaving an unburned area of ~41 km² in the eastern half of the SWRA.

The Snowshoe Hare (*Lepus americanus*) cycle was in an increase phase, near the peak (Kenai National Wildlife Refuge unpubl. data 1983–2015). Other passing vehicles did not stop or interfere with our observations until two male lynx came out of dense cover to the road. Then, almost simultaneously, two approaching vehicles stopped to allow the occupants to also observe and then closely follow the lynx for ~1.5 km down the road before they passed by them. The temperature was ~-2.8°C, snow depth ~0.5–1.0 m, and snow-plowed-berms on both sides of the road were ~1.0–1.5 m high.

We used our images (385 photographs and 17 short videos of 1–9 min duration) to confirm the sex of two of the three lynx (two males, M1 and M2; we could not visually confirm the sex of L3) and reconstruct the timing of their behaviours, even though vegetation and the vehicle windshield obscured or distorted many images. We identified three phases of the interaction and use a standardized ethogram with its terminology and behavioural definitions for the Felidae recommended by Stanton *et al.* (2015) with specific behaviours shown in italics on first use.

Phase I, duration 1 h 46 min (1708–1854), was non-agonistic interaction between M1 and L3, ~30 m from the road (Figure 1a). We did not observe L3 again.

Phase II, 35 min (1854–1929), was agonistic behaviour between M1 and M2 that began when M2 suddenly appeared, rapidly *walking* up the road behind our vehicle toward site A. After the apparently *alerted* L3 suddenly disappeared from view, M2 began interacting agonistically with M1, both frequently *vocalizing* and posturing. We did not observe any physical contact between the males even though they sometimes faced each other <0.5 m apart (Figure 1b); neither scent marked.

Phase III (Figure 1c–e), 39 min (1929–2008), was aggression, scent marking, and fighting, as M1 closely followed and aggressively escorted M2 from site A (perhaps from M1's territory) back along the road on which M2 arrived, to a point 1.7 km east of site A. Then, each male separately disappeared into dense vegetation on opposite sides of the road.

Lynx L3 was only observed during phase I; from

the interactions with M1 and the behaviours observed, L3 was probably an adult female in pre-estrus. She tolerated M1's close (<1 m) presence, allowed M1 to closely follow for at least 20 m, and did not exhibit any agonistic behaviour toward M1. We speculate that L3 did not encourage physical contact because she was not yet ready to breed and did not exhibit other "typical" female felid behaviours in estrus, such as urine spraying, head rubbing, the "*flirting run*", or *avoiding* approaches of the male with her paws or loud shrieks (Leyhausen 1979). Furthermore, we did not observe "typical" male felid behaviour with a female in estrus, such as vocalizations, head rubbing, scent marking with urine or feces, or attempted copulation (Leyhausen 1979). Instead, the behaviours we observed were comparable to the courtship or pre-estrus behaviour before mating or copulation described in Domestic Cats (*Felis catus*; Leyhausen 1979; Yamane *et al.* 1996; Petersen 2015) and captive and other wild felids (Leyhausen 1979; Sunquist and Sunquist 2002; Andrews *et al.* 2018). Alternatively, the long non-agonist interaction between M1 and L3 may have had nothing to do with breeding: L3 was an adult female merely associating with M1. However, because we observed M1 and L3 in the early breeding season and adult lynx generally do not travel with other adults outside the breeding season (O'Donoghue *et al.* 2010), we probably observed pre-breeding behaviour. We also discount a third possibility: L3 was an adult male travelling with M1. Adult lynx are known to sometimes travel together when prey densities are low (O'Donoghue *et al.* 2010); however, hare densities were rapidly increasing near their peak, not low, during our observation (Kenai National Wildlife Refuge unpubl. data 1983–2015). Finally, based on other solitary felid behaviour during the breeding season, it appears unlikely that two adult male lynx would travel non-agonistically together.

We interpret phase II of the behavioural sequence as attempts by newly arriving M2 and M1 to establish territorial dominance or to mate with L3. They displayed their body size by posturing, their facial expressions by the position of their ears and facial ruffs, and their temperament by their loud and piercing vocalizations. The most notable aspect of their behaviour was the highly variable, loud, vocalizing that most closely met Stanton *et al.*'s (2015) criteria for yowling in felids. It varied rapidly in frequency and at least two-fold in intensity. It is believed that female Eurasian Lynx can estimate, from a distance, the "quality" of a potential mating partner by his long distance calls, because they are correlated with the level of testosterone in his blood plasma (Rutovskaya *et al.* 2009). During the mating season, humans are reported to hear the long distance calls of Eurasian

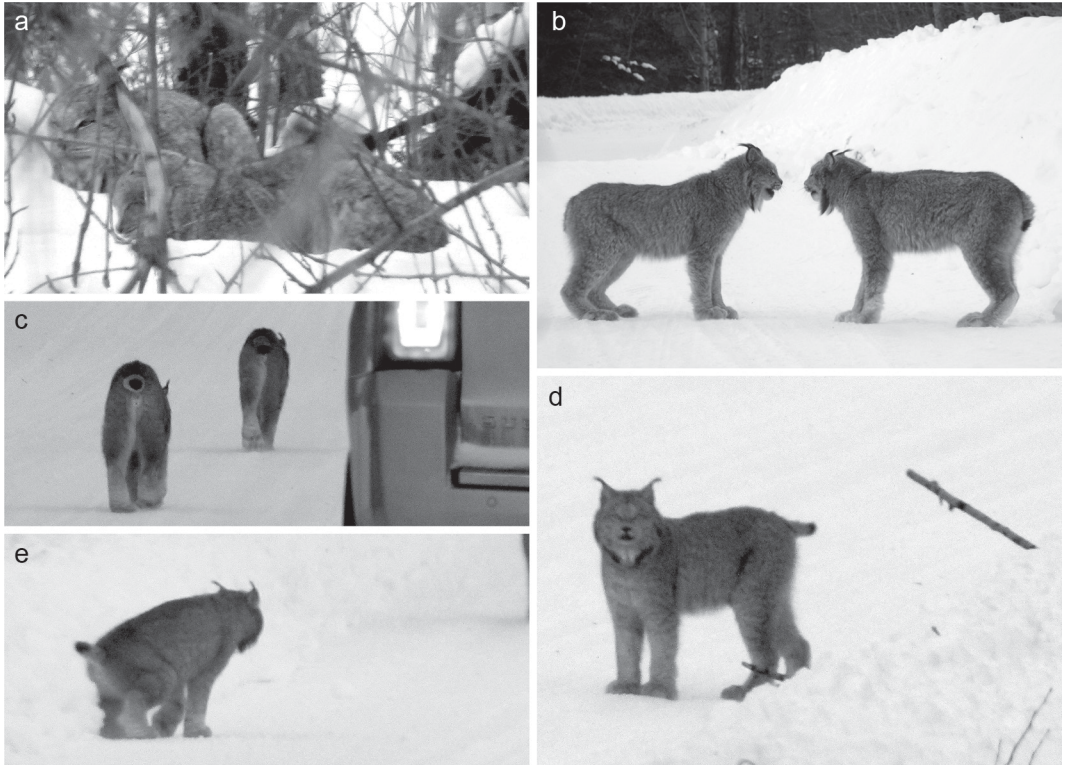


FIGURE 1. Interactions between Canada Lynx (*Lynx canadensis*). a. Lynx M1 crouches in the left background; lynx L3 with eyes closed crouches in front of him. b. Lynx M1 (right) and M2 (left) face each other, yowling, after entering the road. Note white markings on feet of M1. c. Lynx M1 walks closely behind M2 down the road, both lynx ignoring two vehicles driving closely behind them. Note the positions of their tails (M1's tail is held straight out, M2's tail down). d. After scent marking and head rubbing against a branch sticking out of the snow berm, lynx M2 looks back up the road at following M1. e. Lynx M1 scraping his hind feet after scent marking over ("overmarking") a scent mark just left by M2, still partly visible at upper right. Photos: T.N. Bailey and B.N. Bailey.

Lynx from 2 km away (Erofeeva and Naidenko 2012) and those of Bobcat (*Lynx rufus*) from 1.6 km (Young 1958).

From our photographs and videos, it appeared M1 was perhaps the calmer, more secure in temperament, of the two males. M2 appeared more agitated, at first unwilling to move but also the first to eventually leave site A. It also exemplified a general pattern of aggressive behaviour among male felids during the mating season, which usually, but not always, suggests that males attain dominance by ritualized vocal and visual displays and avoid actual fighting (Leyhausen 1979).

We interpret phase III of the behavioural sequence as M1's successful attempt to drive M2 out of its territory and perhaps prevent M2 from mating with the presumed female L3. Among Domestic Cats, fighting rarely occurs near a receptive female (Bradshaw 2016); when it occurs between two males, the heaviest male most often wins (Yamane *et al.* 1996). Physically, M2 appeared younger and perhaps slightly

smaller than M1. Behaviourally, M1 appeared more confident (calmer) and less aggressive than M2, who more often appeared more aggressive (position of ears, retreating). Of interest, M1 did not *chase* M2, nor *run* or *trot* after him. M1 merely walked behind him at a steady pace as M2 retreated.

We are not certain whether M1 escorted M2 from his territory. Several observations favour this interpretation: (1) M1's persistence to drive away M2 ~1.7 km back down the road (the direction M2 apparently came from); (2) M1's behaviour to overmark M2's frequent scent marks as they retreated and, thus, reaffirm his social status; and (3) M1's possible "status as winner" after their brief physical fight. Although fighting is apparently rare among Canada Lynx (Sunquist and Sunquist 2002; Poole 2003), torn ears and broken canines indicate that male lynx sometimes fight (Mowat and Slough 1998; T.N.B. unpubl. data). In a study of Iberian Lynx (*Lynx pardinus*), one suffered serious injury during an apparent territorial

fight (Ferrerás *et al.* 1997). A resident female Eurasian Lynx fought and drove away an unidentified lynx (Wölfel and Wölfel 1996). Amongst male Eurasian Lynx, in four aggressive encounters among five males over a 9-year study period, two were fatal, all occurred during the mating season, and three involved the takeover of a home range by the intruder (Mattisson *et al.* 2013). Male Eurasian Lynx also intensively mark their territories during the breeding season (Schmidt *et al.* 1997). Bobcats also visited scent-marking sites (“community sites”) most frequently during January, presumably at the peak of their courtship and mating (Allen *et al.* 2015). We note that despite about 1 h of sometimes close (<0.5 m) contact, fighting between the two males lasted only about 3 s without any apparent physical injuries, suggesting that these two adult male Canada Lynx resolved their conflict mostly by ritualized, non-injurious behaviour.

As reported for other wild solitary felids (Bailey 1993; Krofel *et al.* 2017; Rafiq *et al.* 2020), our observation supports the view that human infrastructure, such as roads and trails, may serve as important pathways for the maintenance of home ranges, social cohesion, and the exchange of olfactory information among Canada Lynx and, by coincidence, make them more vulnerable to human exploitation.

Author Contributions

Writing – Original Draft: T.N.B.; Writing – Review & Editing: T.N.B. and B.N.B.; Methodology: T.N.B. and B.N.B.

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SUPPLEMENTARY MATERIALS:

APPENDIX S1. Detailed field observations of three Canada Lynx (*Lynx canadensis*), 14 March 2020, in the Skilak Wildlife Recreation Area, Kenai National Wildlife Refuge, Alaska, USA.

VIDEO S1. Male Canada Lynx (*Lynx canadensis*) M1 and M2 agonistically interacting after emerging from dense vegetative cover and before entering the road. Sequence begins with M1 sitting in the snow on the right. Videographer: Brian Bailey. Location: Kenai National Wildlife Refuge, Alaska. Date taken: 14 March 2020. <https://vimeo.com/414965666>.

VIDEO S2. Male Canada Lynx (*Lynx canadensis*) M1 and M2 interacting on the road before M2, final frame on the left, leaves site A. Videographer: Brian Bailey. Location: Kenai National Wildlife Refuge, Alaska. Date taken: 14 March 2020. <https://vimeo.com/414994144>.