

## SUPPLEMENTARY MATERIALS:

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

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

#### *Phase I: Non-agonistic behaviour of M1 and L3* (duration 1 h 46 min)

From our moving vehicle, we saw a lynx ~50–60 m ahead of our vehicle exit the road to our right. We slowly moved to the location and saw an adult lynx (L3), *sitting* in the snow, with another lynx (M1), ~3 m in front of it who quickly disappeared behind trees. After sitting for ~1 min, L3 *crouched* down in the snow *staring* in the direction of M1. After another ~10 min, M1 appeared behind L3 and crouched down facing it less than 1 m away. Both lynx periodically looked in our direction, were aware of us, but apparently were not visibly alarmed. During at least 23 min, the apparently relaxed M1 often closed his eyes as if *sleeping*. After 49 min, L3 got up, *stretched*, turned 180°, and crouched down again now facing M1, their faces ~1 m apart (see Figure 1a in main text).

We did not observe either lynx vocalize, *head rub*, or *urine spray*, behaviour traits common to most felids during estrus (Leyhausen 1979). Both lynx appeared *calm* and *relaxed*, especially M1. After they *socially-stared* at each other for 39 min, L3 got up and slowly walked ~20 m away from M1, closer to our parked vehicle. M1 quickly got up and *followed* L3. L3 then crouched down under several tall spruce trees facing M1 ~1 m away, which also crouched and faced L3 but was partially hidden from our view by spruce trees. They remained facing each other for ~55 min when L3 became alert, after it looked to its right, beyond M1 in front of it. L3 quickly got up, rapidly walked ~20 m from site A, and crouched down *ears forward*, looking, slightly alarmed, toward the road behind our vehicle. At that time, we saw M2 rapidly approaching. M2 disappeared from the road travelling toward where we last saw M1 at site A. As L3 entered vegetative cover and disappeared from view, we began to hear loud *yowling* where we had last seen M1 with L3. Although L3 may have been waiting nearby, as female felids sometimes do when

two males are fighting (Leyhausen 1979), we did not observe L3 again.

#### *Phase II: Agonistic behaviour between M1 and M2* (duration 35 min)

We considered at least four possibilities, in decreasing order, to explain how M2 located M1 and L3 during our observation. Felids use long distance calls variously named “*caterwauling*” (Young 1958), “*mewing*” (Peters 1987), “*loud wailing*” (Mowat and Slough 1998), the “*main*” call (Sunquist and Sunquist 2002), and “*yowl*” (Stanton *et al.* 2015) to locate each other. Thus, perhaps previous vocalizing by L3 or M1 attracted M2. A second possibility is that M2 followed tracks in the snow of L3 or M1. Third, M2 could have detected the odour from scent marks (urine, faeces, or anal gland secretions) or body odour of L3 or M1. Fourth, perhaps M2 coincidentally encountered L3 and M1.

Immediately after the alert L3 disappeared into dense vegetation at 1854 and M2 appeared on the scene at site A, we heard loud yowling. After 2 min, we saw M2 sitting and M1 *standing* and facing each other <0.5 m apart, at the same site where L3 and M1 were last seen together. Both males socially-stared at each other and continuously yowled loudly for ~25 min. Both males positioned their *ears back*, not *ears flat*, against their necks, a high intensity felid defensive posture (Leyhausen 1979). While vocalizing, both males spread their facial ruffs, perhaps to increase the size of their faces. At times, M2 swallowed *excess saliva* while yowling and licked his mouth. The pupils of his eyes were dilated when he yowled, a sign of increased adrenaline flow, or fear, related to felid defensive behaviour (Leyhausen 1979). We could not then see M1’s face or eyes at this time but later we also observed him swallowing excess saliva when they were yowling at each other with their mouths partially open at close (<1 m) range.

During the confrontation, M1 got up and stood in

front of sitting M2, less than ~1 m away. M1 and M2 postured by sitting, crouching, and standing facing each other <1 m apart. M2 then backed up, turned, and slowly walked away from M1 toward where we last observed L3. M1 immediately followed him toward the road. Both males then moved ~20 m near where we last saw alert L3. Both males stopped at the edge of the road where M2 stood staring at M1 who sat down in the snow between him and where we had last seen L3. After several minutes, M2 turned away from M1 and descended ~1 m down the plowed snow berm onto the road (Video S1 in main text). M1 quickly followed. M2 first walked west on the road but when M1 also came on the road, M2 *retreated*, reversed direction, and walked east to confront M1. However, the two oncoming vehicles, now stopped, may also have deterred M2 from advancing further westward. When M1, who was on the main road, saw M2 reverse direction and start walking east via the short pullout, he quickly walked to the opposite end of the pullout to confront M2. They now faced each other again at close range, each sometimes swiftly *raising their paws*, yowling at each other, swallowing excess saliva and licking their mouths (Video S2 in main text). During this ~35 min confrontation, we did not observe any physical contact between the males despite that sometimes they faced each other less than 0.5 m apart (Figure 1b in main text). Neither male had yet scent marked.

*Phase III: Aggression, scent marking and fighting behaviour as M1 closely follows M2 on road 1.7 km from site A, perhaps from M1's territory. (duration 39 min)*

The behaviour between M1 and M2 now began to change. After confronting M1 in the road pullout, M2 climbed the high snow berm on the opposite side of the road within ~2 m of our parked vehicle, entered the road, and then walked rapidly east on the road as if *fleeing* or avoiding M1. M1 closely (<10–30 m) followed M2 as did the two other vehicles. Because they were driving parallel to each other ahead of us, they periodically blocked our view of the lynx (Figure 1c in main text). In photographs, we notice that as M1 followed M2 down the road, M2's tail was often *tail bent down*, toward his hindquarters, while M1's tail was *tail parallel*, *tail bent half-up*, or *tail up*, a possible sign of dominance (Leyhausen 1979).

We now noticed for the first time that M2 sprayed urine, first on the right then on the left side of the road. We were unable to view M1's response, if any. Farther down the road, M2 sprayed urine on a branch sticking out of the snow berm on the right side of the road, briefly head rubbed his cheek against the branch and looked back up the road, with ears forward, toward M1 who was still closely following behind him

(Figure 1d in main text). M2 then crossed the road and scent marked at least once. As M1 approached one of M2's scent marks, he squatted and scent marked with either his urine, anal glands, or a small amount of faeces and then *scraped with his hind feet* (Figure 1e in main text), a behaviour ("overmarking") also documented by remote cameras in Eurasian Lynx (*Lynx lynx*; Vogt *et al.* 2014). As they walked down the road, M2 periodically stopped to look back to see if M1 was still closely following behind, which he was.

Four minutes later, M2 turned to confront M1 who was close behind him. Suddenly, both males *reared*, standing upright on their hind feet facing each other, fighting with their raised paws, and *raking* fur from each other with their outstretched claws. It was difficult to determine which of the two males *attacked* first. Both males appeared to fight only with their front paws, one *jumping* over the other; we did not observe one male *bite* the other. Then M2 either accidentally slipped on the road's icy surface as he made physical contact with M1, or M1 knocked him down. In a blur, M2 *rolled on his back*—an extreme feline defensive posture (Leyhausen 1979)—to defend himself from M1 but quickly got up to face M1. Now, both upright again, they continued to face and stare at each other, yowling loudly, their noses almost touching. There was also a conspicuous amount of fur from one or both of the lynx scattered on the road. The actual physical fight lasted only a few seconds. We examined the fighting site later, but did not find any blood in the snow by the dislodged fur. Neither lynx appeared visibly injured from the fight. Leyhausen (1979: 189–190, Figure 17.1) described in detail, and in a photograph, a similar type of ritualized fighting among Domestic Cats (*Felis catus*) and characterized it as "defense of a territory" fighting.

Immediately after the fight, there was another faceoff, where both males stood less than 1 m apart with M1 standing taller than M2. M2 sat down first, then got back up, both males then sat down, M2 got up again, turned away and continued walking down the road with M1 following. M2 climbed up the snow berm on the left side of the road and scent marked. M2, always ahead of M1, scent marked on both sides of the road, sometimes at the base of the snow berm and sometime on top of the berm. M1 seemed intent just to *pursue* M2, to keep him moving forward and sometimes, when we could see him, scent marked again over M2's scent marks (i.e., overmarks).

Three minutes later, both males left the road and again closely encountered each other among some tree saplings on the far side of the snow berm. During this encounter, M2 periodically *head butted*, pushing his head against a 3-cm-diameter sapling toward M1, who eventually sat down watching the

display. M2 head butted the sapling, rocking it back and forth, with his nose and forehead, perhaps displacement behaviour (Leyhausen 1979), while both yowled at each other, their heads less than about 1 m apart. M2 then backed up, left the sapling area and continued east down the road with M1 again following him. Two minutes later, M1 scent marked on the right side of the road, and after another 7 m, left the right side of the road and disappeared into the forest. It was the last time we saw M1. We were 1.7 km east of site A and closer (1.4 km) to the edge of the burn from the Swan Lake Fire. Meanwhile M2 continued down the road another 0.1 km seemingly unaware M1 had left the road behind him. M2 climbed the snow berm on the left side of the road, stopped to look back for M1 but did not see him. He then came back onto the road and reversed his direction apparently looking for M1. M2 exited the road near the same side where M1 left the road and continued in a 360° circle, apparently searching for M1, until he returned to the place where M2 previously left the road. M2 crossed the road, looked back up the road, may have scent marked, and disappeared into the forest on the left side of the road, opposite the direction taken by M1. We never saw M2 again; the time was 2008 (3 h later), 2 min after official sunset and we were, via the road, 1.8 km east of site A.

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