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RESEARCH ARTICLE

Motion-sensitive cameras track population abundance changes in a boreal mammal community in southwestern Yukon, Canada

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Abstract

Motion-sensitive cameras are commonly used to monitor wildlife occupancy rates; however, few studies have assessed whether data from cameras are correlated with density estimates obtained from more traditional labor-intensive methods such as those based on capture-mark-recapture. We used data from a boreal forest community to test whether camera data were correlated with densities estimated from independent monitoring methods. We placed 72 covert cameras in the forest around Lhù'ààn Mân' (Kluane Lake), Yukon, Canada, for 7 years and tracked changes in population densities by camera hit rates. We independently estimated population densities of snowshoe hares (*Lepus americanus*) and red squirrels (*Tamiasciurus hudsonicus*) using capture-mark-recapture via live trapping, and Canada lynx (*Lynx canadensis*), coyotes (*Canis latrans*), and moose (*Alces americanus*) by snow track transects. Density estimates obtained from conventional aerial surveys were also periodically available for moose. Except for red squirrels, camera hit rates were highly correlated with population density estimates obtained by traditional methods, including across a large range of estimated densities corresponding to cyclic population dynamics in several species. Accordingly, we infer that motion-sensitive cameras could supplement or replace traditional methods for monitoring key species in boreal forest food webs. Using

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cameras to monitor population change has several advantages; they require less effort in the field, are non-invasive compared to live-trapping, include multiple species at the same time, and rely less on weather than either aerial surveys or snow track transects. Tracking changes across the vast boreal forest is becoming increasingly necessary because of climate and landscape change and our data validate the use of motion-sensitive cameras to provide a useful quantitative method for state-of-the-environment reporting.

KEYWORDS

boreal forest, camera hit rates, camera trapping, coyote, lynx, motion-sensitive cameras, population density, red squirrel, snowshoe hare

Monitoring population abundance over time is fundamental to understanding how species respond to environmental and human-caused change (Moussy et al. 2022, Krebs et al. 2023). The boreal forest is one of the largest biomes in North America and requires sustained monitoring to determine the status of the fauna and the flora of this continent-wide ecosystem (Murray et al. 2017). For 50 years, researchers have monitored some of the vertebrate species in the Yukon boreal forest in Canada using labor-intensive methods such as capture-mark-recapture (Krebs et al. 2001, Boonstra et al. 2018), snowtracking (O'Donoghue et al. 1998, 2023), and radio-telemetry tracking of individuals (Studd et al. 2021). To use long-term monitoring effectively to assess conservation concerns for threatened and keystone species in relation to climate change and human disturbance effects, simple but effective methods are required. Motion-sensitive cameras provide a method for assessing changes in wildlife abundance over large areas with minimal effort. Much camera work involves measures of occupancy, but measures of occupancy give no insight to which species might be of conservation concern because of declining abundance. To know that conservation or management action is needed, we require studies of population dynamics, and, at a minimum level, the knowledge of population density and how it is changing.

The camera literature is already extensive and excellent reviews of the problems, pitfalls, and trade-offs of using camera data for estimating occupancy or density are available (Burton et al. 2015, Conner et al. 2016, Abolaffio et al. 2019, Evans et al. 2019, Green et al. 2020). Many researchers have analyzed the theoretical problems of using cameras to estimate density of unmarked animals (Nakashima et al. 2018, Luo et al. 2020, Garrote et al. 2021, Ness et al. 2022). Well-designed empirical tests of the various models now available have been used to assess how well we can estimate the population density of a single species using arrays of cameras (Luo et al. 2020, Becker et al. 2022, Jensen et al. 2022), but long-term studies of an entire wildlife community are lacking.

It is relatively rare that camera-based density or abundance estimates are compared to estimates derived from methods used prior to the advent of camera data. It cannot be assumed that different methodologies produce comparable results without such tests. Given that methods such as live trapping and aerial surveys require extensive resources and are not sustainable to repeat every year, motion-sensitive cameras could provide a feasible method of determining population change across a broad range of species if the predicted densities from camera approaches are comparable to those measured using more intensive field methods.

Beginning in 2016 we deployed motion-sensitive cameras in a Yukon study area where we have been monitoring density changes of small mammals and mammalian predators for nearly 50 years. Our focus was on snowshoe hares (*Lepus americanus*), red squirrels (*Tamiasciurus hudsonicus*), lynx (*Lynx canadensis*), and coyotes (*Canis latrans*) because they are the dominant prey and predators in this boreal ecosystem and because we have for each of them independent density estimates derived from live-trapping for capture-mark-recapture, intensive behavioral observations, and snow track transects. We had 2 objectives: to compare camera-derived indices of abundance or density to those derived from our standard methodologies and to provide an initial assessment of the effectiveness of cameras for monitoring density change of other vertebrates in the study area such as moose (*Alces americanus*). Because hare and predator populations undergo 9–10-year fluctuations in the southwest Yukon (Krebs et al. 2001), and the study period encompassed almost a complete cycle, we were able to assess the performance of camera-based estimators across a range of population densities for several species. We also report changes in relative abundance for species for which we do not have density estimates using traditional methods but that are present in the study area (e.g., wolves [*Canis lupus*], bears [*Ursus* spp.], wolverine [*Gulo gulo*], grouse).

STUDY AREA

This study occurred in the boreal forest near Lhù'ààn Mân' (Kluane Lake, 61°N, 138.5°W), approximately 60 km north of Haines Junction, Yukon from 2017 to 2022 in an area where we have been studying the boreal food web since 1973 (Krebs et al. 2023). Briefly, the 350-km^2 study area is in the Shakwak Trench, a low-elevation geological depression in a landscape otherwise dominated by rugged mountains, alpine meadows, and glaciers (Figure 1). Boreal forest dominated by white spruce (*Picea glauca*) and trembling aspen (*Populus tremuloides*) is the main

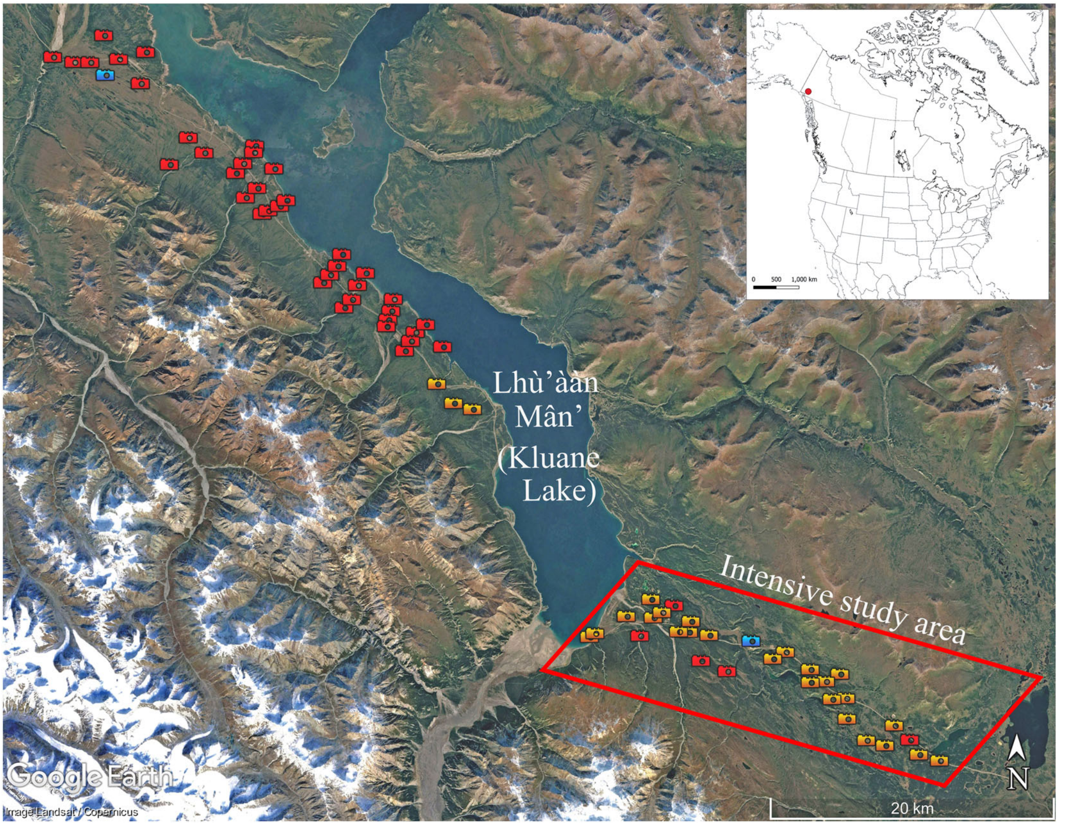

FIGURE 1 Locations of motion-sensitive cameras (*n* = 72) placed in the boreal forest near Lhù'ààn Mân' (Kluane Lake), Yukon, Canada (61°N, 138.5°W, red dot on inset map). The yellow cameras were installed in 2016 or earlier, the red cameras were installed in 2017, and the 2 blue cameras were installed in 2020 and 2021. The intensive study area where we obtained independent density estimates is indicated with a red box.

vegetative cover. Shrublands, wetlands, remnant grasslands, small ephemeral creeks, and ponds and lakes were interspersed throughout the forest. Summers, May to September, are cool and short, while winters are long and cold, extending from October to April. Human density and infrastructure is exceedingly low in the study area, which is bisected by the Alaska Highway. In addition to our target species (red squirrels, snowshoe hare, lynx, coyote, moose), other vertebrate species regularly occur in the study area (Table 1). A detailed account of the vegetation, climate, species, and their interactions in the study area is provided in Krebs et al. (2001) and there has been no major human disturbance or fires in the area in recent decades. Harvesting of animals in the study area is minimal because our cameras were located in the Kluane Wildlife Sanctuary, adjacent to Kluane National Park, and protected from hunting and trapping by people other than First Nation citizens.

METHODS

Motion-sensitive camera surveys

We used a mix of camera models that changed with availability from manufacturers over the course of our study. In 2016 and 2017, we used Reconyx PC900 (Reconyx Inc., Holmen WI, USA), Bushnell Trophy Cam (Bushnell Outdoor

TABLE 1 Number of camera hits (based on a 2-minute window for unique detections) for the major boreal forest mammal species and grouse in southwestern Yukon during each year.

Species	2016	2017	2018	2019	2020	2021	2022	Total
Target species								
Snowshoe hare	6,121	10,972	6,744	2,874	1,145	931	1509	30,296
Red squirrel	1,080	1,118	1,223	1,166	1,867	1,294	2291	10,039
Lynx	631	968	928	605	426	203	245	4,006
Coyote	206	655	820	635	372	305	249	3,242
Moose	92	137	277	231	341	260	389	1,727
Other species								
Porcupine	115	76	125	149	97	55	70	687
Weasels	0	1	3	1	0	7	5	17
Marten	2	1	11	3	0	1	0	18
Wolf	12	11	32	23	25	23	22	148
Wolverine	4	18	24	14	31	6	16	113
Black bear	51	80	104	86	131	140	156	748
Grizzly bear	49	96	151	127	199	215	185	1,022
Bison	2	16	7	60	41	0	0	126
Mule deer	5	29	24	33	73	114	58	336
Spruce grouse	140	61	58	78	109	147	197	790
Ruffed grouse	12	11	10	10	27	58	122	250
Sharp-tailed grouse	0	0	2	4	4	13	21	44
Total	8,522	14,250	10,543	6,099	4,888	3,772	5,535	53,609

Products, Overland Park, KS, USA) and ScoutGuard SG570 (HCO Outdoor Products, Norcross, GA, USA) cameras; however, beginning in 2018 we replaced Bushnell and ScoutGuard cameras with Reconyx HP2X cameras. These camera models differ slightly in their trigger speed and recovery time, but we tested duplicate cameras at 3 sites and the data collected from all camera models did not produce different rates of detection. All camera models were covert (infrared flash only).

We spaced the cameras out from one another by ≥1 km and placed the cameras where they could be accessed by a road and trail system (within 5 km) in the study area. Camera locations were random with respect to major vegetation types in the study area and matched the cover types on the live-trapping grids and snow track transects. A completely random placement of cameras was not logistically possible in the study area because it would have led to many cameras having most of their field of view obscured and the increased time and cost to access fully random locations was prohibitive. As a compromise, we avoided locations where much of the camera field of view would have been obscured by vegetation and selected places where animals were likely to be encountered. We placed cameras on game trails in the forest and openings that would provide an average camera view of 18 m^2 (range = 3–49 m^2, measured by Reconyx walk test). We avoided sites within 100 m of roads and human-made trails although the area is sparsely populated and confined to 3 small communities next to Lhù'ààn Mân' (Kluane Lake). Human use of the forested study area is negligible. We accessed all cameras by walking, and many camera locations required traversing difficult forested terrain so human disturbance was not a consideration.

We tested mounting cameras at heights from 20–200 cm above ground level and found the lower heights produced the best coverage of all species and the largest field of view. We mounted cameras on average 43 cm (range = 24–70 cm) above ground level in secured lock boxes on trees or stumps and did not move them over the entire study except in a few cases where fallen trees obstructed the field-of-view. We placed cameras facing north to avoid sun hitting the lens and did not use lures or attractants. We set cameras to take 3 still images per trigger with no delay between triggers plus 1 time lapse photo at noon each day to confirm the camera was operating properly and not covered by vegetation or snow. We used lithium batteries that lasted ≥1 year, and changed batteries once per year when we serviced cameras and downloaded photos. We used high speed memory cards (SanDisk Extreme Pro 95MB/s; SanDisk, Milpitas, CA, USA) that had enough memory (32 GB) to not fill even on the few occasions where vegetation blowing in the wind caused thousands of extra photos.

We downloaded photos from all the cameras in June or July each year and uploaded them to a Microsoft Access (Microsoft, Redmond, CA, USA) database purposely developed to facilitate managing the photos. We viewed and manually tagged photos in the database. We re-tagged random image sets and compared the results to check for accuracy. We then uploaded tagged photos to an online repository (WildTrax, https://wildtrax.ca/).

We derived 2 metrics of the relative abundance of our targeted species from the camera photos. The hit rate is the simplest and is the number of times that a species is detected divided by the number of camera days that the cameras were operational. We recorded one hit for a species for every case where there was ≥2 minutes between consecutive photos of that species. Confidence limits for hit rates were based on a Poisson distribution if the number of hits were ≤100 and a normal distribution if >100 (Krebs 1999:122). We also tested a second more involved quadrat-based method, which evolved from the Nakashima et al. (2018) random encounter and staying time (REST) model and was modified by Warbington and Boyce (2020) for data used to develop time-in-front-of-the-camera (TIFC) models.

Comparative data

We have estimates of population size for several species from extensive studies carried out in the area south of Lhù'ààn Mân' (Kluane Lake) where half of the cameras are located (Figure 1). We assumed that the density estimates from the area south of Lhù'ààn Mân' (Kluane Lake) were similar to those in the area northwest of the lake where the rest of the cameras were located because of similar vegetation and topography.

We produced capture-mark-recapture density estimates for snowshoe hares and red squirrels with spatially explicit capture recapture (SECR) methods (Efford and Fewster 2013) and our field methods were described in detail by Krebs et al. (2001). Briefly, we live trapped snowshoe hares on 3 grids in May and October each year using 86 traps per 20 × 20 trapping grid with 30-m spacing as mapped in Krebs et al. (2001). We uniquely marked all newly captured hares with ear tags. We set traps in the evening and checked them the next morning for 3 capture periods by which time on average <1% of hares were unmarked. For red squirrels, we live trapped on 2 grids in May and August each year using 50 traps per 10 × 10 trapping grid with 30-m spacing and ear-tagged all newly captured squirrels. We set traps by 0700 and checked them every 1.5 hours until noon for each of 2 days. We indexed lynx, coyotes, and moose by counting their tracks in the snow along a 22-km transect conducted on a fixed route. We converted the number of tracks per track night per 100 km to density estimates for lynx and coyote using the methods described by O'Donoghue et al. (2023). We completed snow track transects 1–5 days after every fresh snowfall from December through March, resulting in an average of 14 replicate surveys per winter.

We pooled camera data for time periods that best corresponded to independent estimates of abundance (e.g., snowshoe hare hit rates for April and May were pooled to compare with mark-recapture SECR estimates obtained during the same time period). We then used standard linear regression methods to compare camera hit rates to density estimated from SECR or track transects for each species. We carried out all computations in NCSS 2023 (NCSS, Kaysville, UT, USA).

RESULTS

Target species

Over the 7 years of monitoring, we captured >53,000 hits of mammals and grouse in our study area, and the number of hits per year varied over 4-fold (range = 3,772–14,250; Table 1). For our target species, the number of hits over the duration of our study were greatest for hares, followed by red squirrels, lynx, coyote, and moose. For these species, hit rates and TIFC values were highly correlated ($r = 0.96–0.99$) over the seasonal time windows that we analyzed. Consequently, we report here only hit rates and compare these with density estimates from SECR and snow track transect methods. We provide density estimates from all methods for our target species in Table S1 (available in Supporting Information).

Hit rates of snowshoe hares varied both annually (associated with the phase of the 9–10-year cycle) and seasonally within years (Figure 2A). We compared camera hit rates derived from spring (April and May) and autumn (September and October) hare photos to SECR estimated hare population density from spring and autumn live trapping over the 7 years of study (Figure 3A). The correlation (r) between SECR estimates and hit rates was 0.95, R^2 was 0.91, the root-mean-square error (RMSE) was 0.1851 ($n = 14$), and the predictive equation for snowshoe hare density is:

$$\text{SECR density (hares/ha)} = (0.04837) + (0.001561 \times \text{hit rate})$$

We also estimated red squirrel densities by capture-mark-recapture methods in spring and late summer. Camera hit rates for red squirrels (Figure 2B) were not correlated with spring or late summer red squirrel density estimates obtained by live trapping ($R^2 = 0.06$, $n = 14$; Figure 3B).

Monthly camera hit rates for lynx at Kluane were lower in winter (Figure 2C). We compared winter population density for lynx estimated from snow track transects (O'Donoghue et al. 2023) to the estimates of lynx abundance from hit rates calculated from September to November camera data ($R^2 = 0.90$, $n = 7$, RMSE = 10.18, $P < 0.01$; Figure 3C). The snow track transect data are typically from November to March so the timing is slightly misaligned, but during those winter months the cameras were sometimes covered by snow and we were not confident that our field of view measurements in winter were accurate. The predictive equation for lynx is:

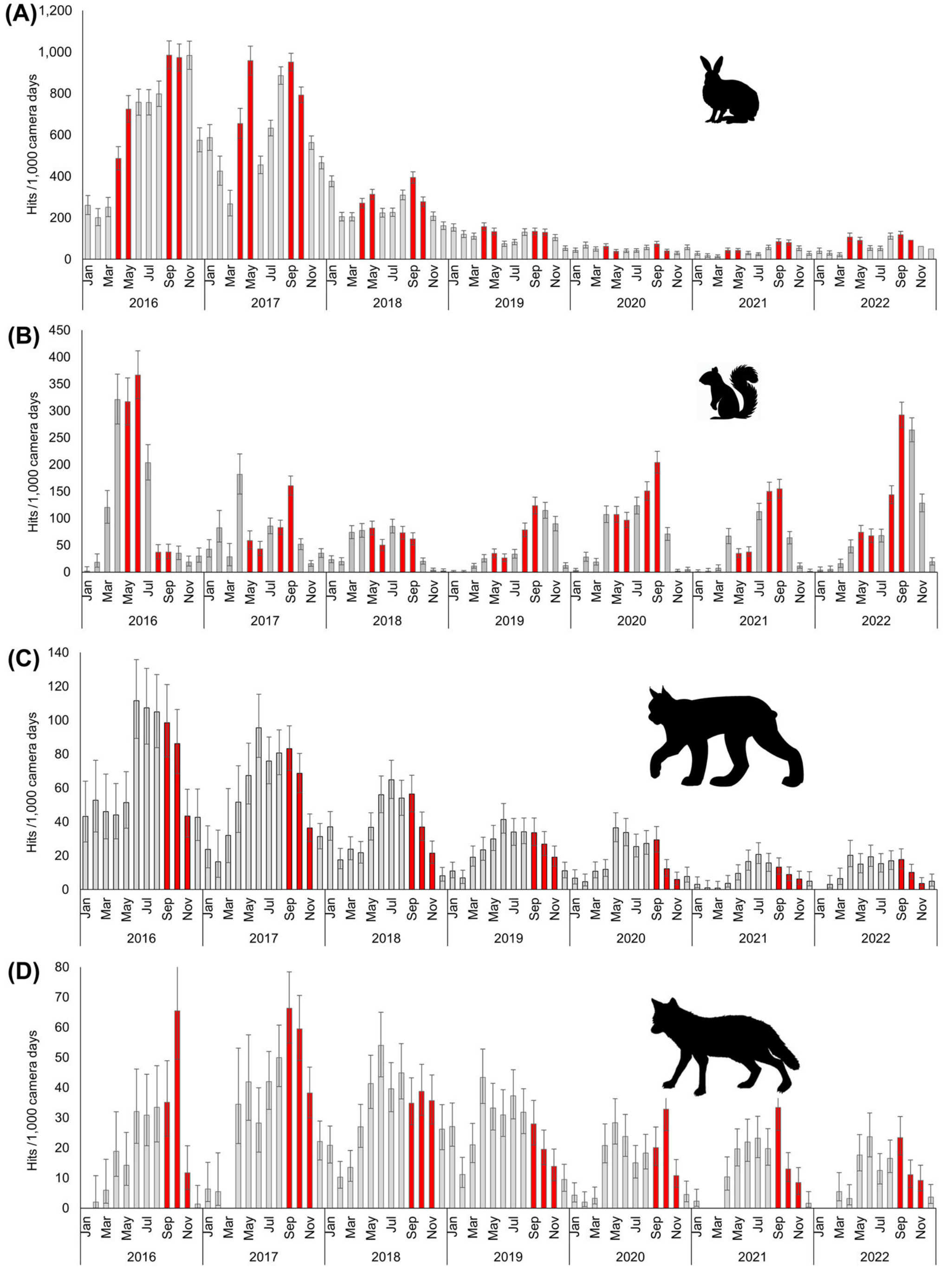

FIGURE 2 Camera hit rates by month during 2016 to 2022 in southwestern Yukon, Canada, with 95% confidence limits. A) Camera hit rates for snowshoe hares; we pooled hits in spring and autumn (red) for comparison with spatially explicit capture recapture (SECR) density estimates for the same time period. B) Camera hit rates for red squirrels; we pooled hits in spring and late summer (red) for comparison with SECR density estimates for the same time period. C) Camera hit rates for lynx; we pooled hits in September to November (red) for comparison with snow track transect density estimates for the following winter. D) Camera hit rates for coyotes; we pooled hits in September to November (red) for comparison with snow track transect density estimates for the following winter.

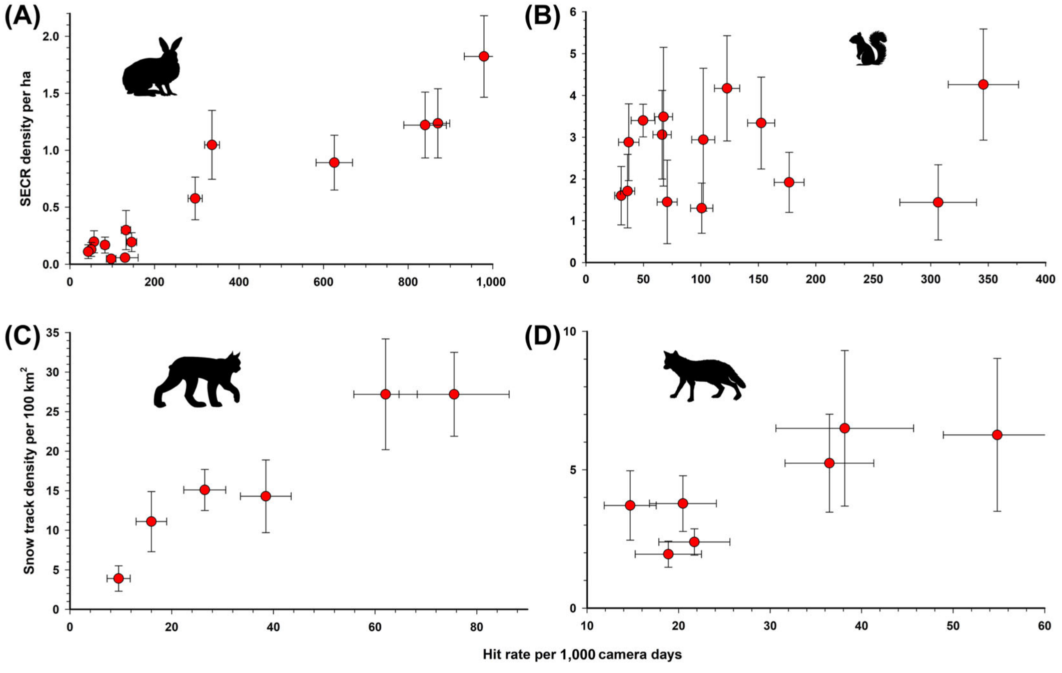

FIGURE 3 Camera hit rates compared to independent estimates of density during 2016 to 2022 in southwestern Yukon, Canada, with 95% confidence limits. A) Yearly camera hit rates for snowshoe hares in spring (April and May) and autumn (September and October) compared with spatially explicit capture recapture (SECR) density estimates for the same time period ($R^2 = 0.91$). B) Yearly camera hit rates for red squirrels in spring (May and June) and late summer (August and September) compared with SECR density estimates for the same time period ($R^2 = 0.06$). C) Yearly camera hit rates for lynx in September to November compared with snow track transect density estimates for the following winter ($R^2 = 0.90$). D) Yearly camera hit rates for coyotes in September to November compared with snow track transect density estimates for the following winter ($R^2 = 0.69$).

$$\text{Snow track transect density (lynx/100 km}^2\text{)} = 3.6803 + (0.33704 \times \text{hit rate})$$

Monthly camera hit rates for coyote at Kluane were also lower in winter (Figure 2D). We compared winter population density for coyote estimated from snow track transects (O'Donoghue et al. 2023) to the estimates of coyote abundance from hit rates calculated from September to November camera data ($R^2 = 0.69$, $n = 7$, RMSE = 1.2048, $P < 0.02$; Figure 3D). The coyote regression is as follows:

$$\text{Snow track transect density (coyotes/100 km}^2\text{)} = (1.2198) + (0.1037 \times \text{hit rate})$$

The conventional method of population estimation for moose is aerial surveys, which cover large areas (e.g., >1,000 km^2; Jung et al. 2009, Becker et al. 2022), and changes in moose numbers can be observed in snow track transects (O'Donoghue et al. 2023). Snow track counts have been conducted at Kluane each year since 1987 (Krebs et al. 2023) and Parks Canada has conducted aerial surveys in the Kluane area (Auriol Range) for 25 of those years (Parks Canada 2022). Moose density estimates from aerial surveys and 3-year running averages of snow tracks per track night per 100 km from snow track transects at Kluane are correlated with $r = 0.59$ (Figure S1, available in Supporting Information). There have been only 3 aerial counts completed during the 7 years of our camera study and consequently we cannot extract a reliable regression for moose density from camera hit rate data.

Other species detected

Other species captured by our motion-sensitive cameras included porcupines (*Erethizon dorsatus*), spruce grouse (*Falcipennis canadensis*) and ruffed grouse (*Bonasa umbellus*) in moderate numbers and wolverine, wolves, marten (*Martes americana*), weasels (*Mustela* spp.), and sharp-tailed grouse (*Tympanuchus phasianellus*) in sparse numbers. We do not have independent data to estimate densities of these species, but the camera data can be used to obtain occupancy rates. Grizzly bears (*Ursus arctos horribilis*) and black bears (*Ursus americanus*) were captured often on our cameras (Figure S2) and in 2.7% of bear camera hits we could not distinguish between the species. Omitting these unknown identifications, black bears comprised an average of 42% and grizzly bears an average of 58% of the bear hits from all the camera data from 2016 to 2022. Wolf snow tracks fluctuated inter-annually (Figure S3), but the camera hit rate was low and the simplest interpretation from the camera data is that wolf numbers were stable over these 7 years (Figure S4). Wolverine camera data showed changes in hit rates, but they were uncommon (Figure S5), restricting our ability to estimate occupancy.

Spruce grouse and ruffed grouse were common in our study area, but we do not have independent abundance data for them in the 2016 to 2022 period that would allow us to compare to camera data. On average we obtained 113 camera hits per year for spruce grouse (Figure S6), whereas ruffed grouse were less common, averaging 36 camera hits per year. Sharp-tailed grouse occurred only in the cameras north of Lhù'ààn Mân' (Kluane Lake) and were sparse with a total of 44 hits over the study period.

Two other ungulates also occurred in the area sampled by our cameras: mule deer (*Odocoileus hemionus*) and bison (*Bison bison*). Both were rare and localized in the Kluane area. We recorded 336 mule deer hits over the 7 years and 126 bison hits. Bison are slowly colonizing the Kluane area from the east so will presumably increase in the future (Jung 2017, Boonstra et al. 2018). Cougars (*Puma concolor*) and fishers (*Pekania pennanti*) have been suggested to be in the area (Jung and Merchant 2005), but we have no camera hits for either species. We had one red fox (*Vulpes vulpes*) photo despite documentation that this species was more common in the region in past decades (O'Donoghue et al. 2010).

DISCUSSION

We have demonstrated that the abundance of some but not all the dominant species in the Yukon boreal forest can be estimated from wildlife camera data and at the same time we can obtain data on occupancy of many other species. This indicates that cameras can improve our understanding of the state of the environment and with sufficient accuracy to show trends of some keystone or threatened species. Conservation and wildlife agencies could save resources and obtain annual population density estimates for select species by the careful use of these camera methods (Green et al. 2020).

The camera data show a dramatic seasonal change in activity for all species. Therefore, camera data from similar time periods should be used for tracking changes in abundance. Mid-winter hit rates were reduced and this was unlikely to be explained by density change alone. The dip in hit rates may be due to decreased activity in winter. The field-of-view of the cameras may also change with varying snow levels in winter and shrub density changes after autumn leaf fall. The fact that activity is lower in the winter months coupled with the risk of cameras getting covered by snow and the difficulty of accessing cameras in winter, support the recommendation that censusing animals with cameras is best avoided in winter months in areas that receive deep snow. We surmise that in the northern boreal forest, the best time for censusing animal populations with cameras is late summer and autumn when animals are no longer confined to natal denning areas and juveniles are mobile. For ungulates, late summer and autumn coincide with the breeding season, when males in particular may be more active and likely to be detected by cameras.

Monitoring red squirrel abundance with cameras is less successful than for other species. There was a wide variation in the number of photos captured of red squirrels depending on camera placement. Cameras placed near or on an active midden captured hundreds of red squirrel photos, whereas cameras placed farther from an active midden captured few red squirrel photos. Red squirrels live in a 3-dimensional landscape and their time on the ground is spatially very concentrated, whereas the cameras are capturing photos only on the ground level. Before cameras can be used to estimate red squirrel populations in the boreal forest, it will be necessary to identify camera distribution and placement designs that increase detections of distinct individuals.

Doran-Myers et al. (2021) compared a variety of density estimation techniques for lynx involving track counts, cameras, and capture-recapture techniques to estimate lynx density in a single year in our Kluane study area. Different measurements and estimators produced a wide range of density estimates (Doran-Myers et al. 2021). Based on our experience following radio-collared lynx and knowledge of the kill rate of lynx on hares in winter (O'Donoghue et al. 1998, Krebs et al. 2001) and the measured population changes in hares, we have shown that camera hit rates follow closely the independently estimated abundance of lynx from snow track transects. The relationship between estimated lynx density and hit rates (Figure 3C) may be curvilinear but with the available data there is no reason to assume that a parsimonious linear regression is not the best fit.

Moose data from cameras in our study area might be improved by covering a larger area within the moose management unit and a longer time series of camera research. Camera data are reliable for monitoring moose densities in Alberta (Becker et al. 2022), but we did not have enough photos of moose, and in the exact areas of alternative aerial survey abundance measures to test this for our study area. The photos we obtained provided an additional method of monitoring condition of moose and the potential spread of winter tick (*Dermacentor albipictus*) in the population and cow-calf ratios.

The predictive equations developed for our southwest Yukon study area are simple, parsimonious, and have good fit. These relationships possibly hold for other regions where the same species occur; therefore, our models could serve in wildlife population estimation across a large geographic range, but this requires further testing. We acknowledge that some site-specific differences may affect these relationships, as may arise from different snow conditions or wildlife activity patterns affecting camera hit rates. Although strong correlations between camera detections and population density are likely to hold for species such as snowshoe hare, lynx, coyote, and possibly moose, some degree of local validation may be needed for robust population estimation. Such validation may involve comparing camera data for each species with traditional estimation methods, but these efforts are logistically challenging and may have limited success if population density varies little during the test. More simply, data filtering criteria could be adjusted to reflect local conditions, which could then be applied to all species. For example, in regions with later seasonal snowfall, the time window with usable images may extend past our November cutoff.

We present these data to support one relatively simple approach to the problem of wildlife monitoring for conservation or management questions for many species. Occupancy is relatively simple, while reliable population estimation requires much more effort. For our analysis, hit rates are simpler to compute than TIFC estimates and have fewer assumptions that may be violated.

MANAGEMENT IMPLICATIONS

Simple camera hit rates are reliable for obtaining relative abundance estimates that are highly correlated with traditional density estimates of select boreal mammals. The use of camera data could strengthen state-of-the-environment reports produced every year by government and non-governmental agencies by putting quantitative data in place of general statements that a species has declined or increased. Our camera data for the uncommon species in our study area suggest that, with sufficient years of sampling, camera data may provide a relative index and simple signal of population trends. Motion-sensitive cameras in combination with the hit rate method evaluated in this study provide a low-cost but accurate method for monitoring population trends in terrestrial vertebrates.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

ETHICS STATEMENT

Research was conducted under University of British Columbia Animal Care Certificate A-17-0111 and A-13-0136, and Yukon Scientists and Explorers Licence 22-10 A and E.

DATA AVAILABILITY STATEMENT

The photos that support the findings of this study will be available in WildTrax (https://wildtrax.ca/) on request from the corresponding author.

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SUPPORTING INFORMATION

Additional supporting material may be found in the online version of this article at the publisher's website.

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