

NOTE

Trail cameras can greatly inflate nest predation rates

John-André Henden  | Rolf Anker Ims | Marita Anti Strømeng

Department of Arctic and Marine Biology,
University of Tromsø – The Arctic University
of Norway, Tromsø N-9019, Norway

Correspondence

John-André Henden, Institute of Marine
Research (IMR), Tromsø N-9007, Norway.
Email: john-andre.henden@hi.no

Present address

John-André Henden, Institute of Marine
Research (IMR), TromsøN-9007, Norway.

Funding information

Regionalt forskningsfond for Nord-Norge;
Tromsø Forskningsstiftelse; Norges
Forskningsråd

Abstract

Photographic monitoring currently provides the most accurate means for identifying nest predators and eventually their role in bird population declines worldwide. However, previous studies have found that commercially available trail cameras represent an artificial structure that tend to negatively bias predation rates, likely through predator neophobia. Based on an experiment in Arctic tundra, involving 50 artificial nests and 30 cameras in each of 2 breeding seasons, we demonstrated that trail cameras attracted corvids (in particular ravens [*Corvus corax*]), which caused an extreme and positively biased predation rate that was consistent over a range of experimental and environmental conditions. We call for new technologies that allow for photographic monitoring of bird nests with minimal visual footprints, in the form of smaller cameras and more efficient internal batteries to minimize novel and conspicuous external features detectable by predators. However, even such improved devices need to be assessed with respect to potential effects on nest predation in each case.

KEYWORDS

Arctic tundra, bird population decline, climate change, corvids, monitoring, raven

Birds constitute one of the biological taxa that are most studied and discussed in context of the ongoing biodiversity crisis. Enhanced nest predation rates may be an influential proximate driver of bird population declines (Kubelka et al. 2018, Roos et al. 2018, Bravo et al. 2020, McMahon et al. 2020). It is crucial to precisely identify species depredating nests to establish the ultimate drivers of nest failure and to devise mitigating actions.

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2024 The Author(s). *The Journal of Wildlife Management* published by Wiley Periodicals LLC on behalf of The Wildlife Society.

Motion-triggered cameras are the most accurate means for predator identification associated with nests (Richardson et al. 2009, Cox et al. 2012). However, a caveat is that such cameras represent a novel structure near the nests that may bias predation rates by attracting or deterring predators. While well camouflaged miniature surveillance cameras (i.e., bullet cameras) may minimize such biases (Cox et al. 2012), the more conspicuous and cheaper commercially available trail cameras (wildlife cameras) are much used in studies of nest predation (Ribeiro-Silva et al. 2018, Hunt et al. 2020, Young et al. 2021, Salewski and Schmidt 2022, Rao et al. 2023). Biases inflicted by use of trail cameras are likely accentuated for ground-breeding birds in barren land classes (agricultural fields, deserts, beaches, tundra), areas offering few opportunities to conceal cameras in natural vegetation. In their meta-analysis, Richardson et al. (2009) found a tendency for nest predation rates to decrease when cameras were deployed across a range of temperate ecosystems in North America, while they reported no cases of clearly increased predation owing to camera deployment. More recent studies have reinforced this finding in temperate ecosystems in Europe (Bravo et al. 2020).

Recent studies have documented increased nest predation in alpine and Arctic tundra ecosystems associated with climate change, albeit without precisely identifying predator species (Lehikoinen et al. 2014, Kubelka et al. 2018, Ims et al. 2019, Lehikoinen et al. 2019). This motivated us to assess experimentally whether conventionally deployed wildlife or trail cameras could be used in relatively barren tundra without significantly deterring or attracting nest predators to provide a means for unbiased estimates of species-specific predation risk. As clutch size and the degree of natural concealment of nests varies profoundly among different bird species and land cover types in tundra, we also accounted for such factors in the experimental design and the statistical analyses.

STUDY AREA

We conducted the study on the Varanger Peninsula, between 70–71° N and 28–31° E, in northeastern Norway (Figure 1). The study area is situated in low-Arctic shrub tundra (bioclimatic sub-zone E; Pedersen et al. 2021). The vegetation is mainly composed of dwarf shrubs (Soininen et al. 2018). The bird community is composed of mainly arctic-alpine passerines, shorebirds, and ptarmigans (*Lagopus* spp.; Ims and Henden 2012, Henden et al. 2013). Predators likely inflicting nest predation are corvids, skuas (*Stercorarius* spp.), foxes (*Vulpes* spp.), and mustelids (*Mustela* spp.; Ims et al. 2013b, 2017) of which the raven (*Corvus corax*) is numerically dominant in this geographic region (Killengreen et al. 2012, Henden et al. 2014).

METHODS

Experimental design

We conducted the experiment in 2 bird breeding seasons (years 2018 and 2019). In each year, we deployed 50 artificial nests with quail eggs by making a small depression in the ground vegetation layer, of which 30 nests were deployed with a camera. Artificial nests have become a widely used method for estimating how predation risk may be associated with environmental drivers (McKinnon et al. 2010a, Bravo et al. 2020). Although this method has been criticized for not yielding reliable estimates of absolute predation probabilities (Faaborg 2010), artificial nests with quail eggs provide useful estimates of relative predation risk for ground-breeding birds in tundra (McKinnon et al. 2010b). In general, we think artificial nests are especially suitable in studies where experimental interventions (like the presence of novel technology or features in the landscape) could inflict increased predation on real nests, especially when studying rare or threatened species.

We deployed the nests at 10 locations along 5 altitudinal transects (Figure 1). The distance between adjacent nests along a transect was 500 m, while the distance between adjacent transects was 1,000 m. The altitudinal transects ranged from an average of 233 (SE = 6.3) meters above sea level (masl) at their lower end to 376 (SE = 10.2) masl at the higher end. The altitudinal transects represented a consistent gradient in ground vegetation

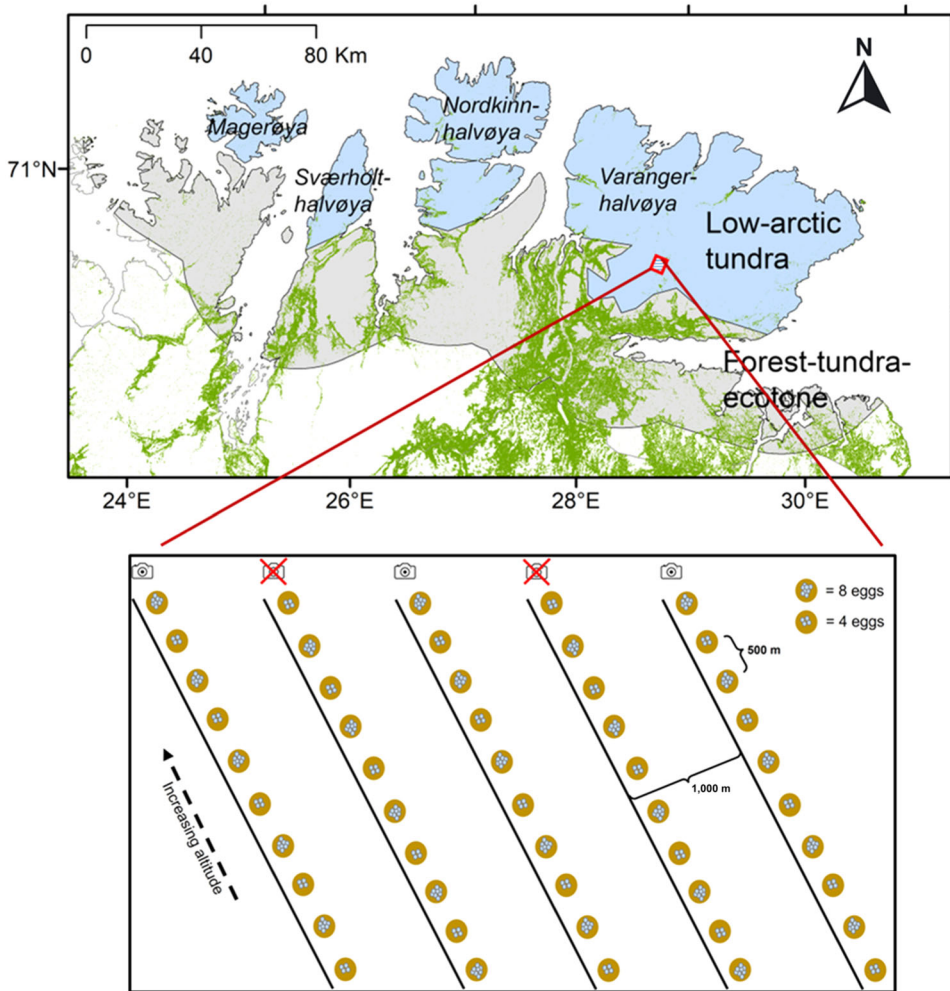


FIGURE 1 Map of the northeastern part of Norway with the positioning of the low-Arctic tundra (blue) and the adjacent forest-tundra ecotone (Pedersen et al. 2021) and the location of the study area (red square). The lower panel shows the experimental design with alternating altitudinal transects with and without cameras on the artificial nests and alternating clutch sizes (4 and 8 eggs) in the nests within transects in 2018 and 2019.

cover, and hence, the degree of nest concealment. Indeed, several previous studies have shown that vegetation cover strongly modifies nest predation rates (Ims et al. 2019, Laidlaw et al. 2020, Bravo et al. 2022). As a proxy of nest concealment, we measured the maximum height of vascular plants within a triangular sampling frame (sides 40 cm) centered on each nest. This vegetation measure, which is strongly correlated with the degree of concealment (cover) of nests (Ims et al. 2019), declined with altitude and averaged 25 cm (SE = 10) at the lower end and 12 cm (SE = 4) at the higher end of the transects.

The clutch sizes of ground-breeding bird species in the study area range from 3–4 eggs in shorebirds to 8–12 eggs in ptarmigans. The appearance of nests and quail eggs we used were similar to that of real ground-breeding birds in tundra, such as the dotterel (*Charadrius morinellus*; Ims et al. 2019). Quail eggs have a coloration and size similar to both shorebirds and ptarmigans breeding in tundra (McKinnon et al. 2010b, Ims et al. 2019). As clutch size may affect predation rates (Bravo et al. 2020), we included this factor in the experimental design by alternating every other nest along the transects with 4 and 8 quail eggs (Figure 1). To assess the effect of camera presence on nest predation rates,

we deployed cameras (Browning Spec Ops Extreme; Browning Trail Cameras, Birmingham, AL, USA) on nests on 3 of 5 altitudinal transects (i.e., 30 cameras per year; Figure 1). We chose an unbalanced design with respect to the camera treatment because we aimed to obtain a rather large sample of photos for identifying predator species. The 3 altitudinal transects with cameras were maximally dispersed among the 2 transects with no cameras (Figure 1). The vegetation height was similar at nest sites with and without cameras (camera: mean = 14.6 [SD = 13.8] cm, no-camera: mean = 14.4 [SD = 14.6] cm).

Camera dimensions were 13.7 × 10.6 × 7.5 cm, with trigger and recovery speeds of 0.43 and 0.8 seconds, respectively, interpolated photo resolution of 20 megapixels and the possibility of both motion-triggered and time-lapse settings. The camouflage painted cameras were mounted on an aluminum pole (2 cm diameter) approximately 30–50 cm above the ground and 1.5–2 m from the nest (Figure 2). The cameras were motion-sensor triggered and took 2 images for each trigger event and with a 5-second delay until the next potential trigger event. In addition, the cameras were set on a time-lapse schedule of 1 image every hour, to assess if a lack of pictures was due to the camera not working or a lack of predator activity.

To speed up deployment rate, we pre-programmed all cameras and prepared the predetermined clutch size prior to deployment. The deployment time of each nest setup was approximately 3–4 minutes. Only one person was present at each nest setup upon deployment, and we temporarily stopped deployment if we observed potential nest predators (e.g., ravens) in the area. To minimize potential scent trails for predators that use olfactory cues, we wore rubber boots and gloves when walking a straight-line route from nest site to nest site along the transects and during deployment of the nest setups.

In 2018, we deployed cameras simultaneously with the eggs, while in 2019 we postponed nest making and deployment of eggs 2 days after the cameras. For nests without cameras in 2019, we visited the nest site only

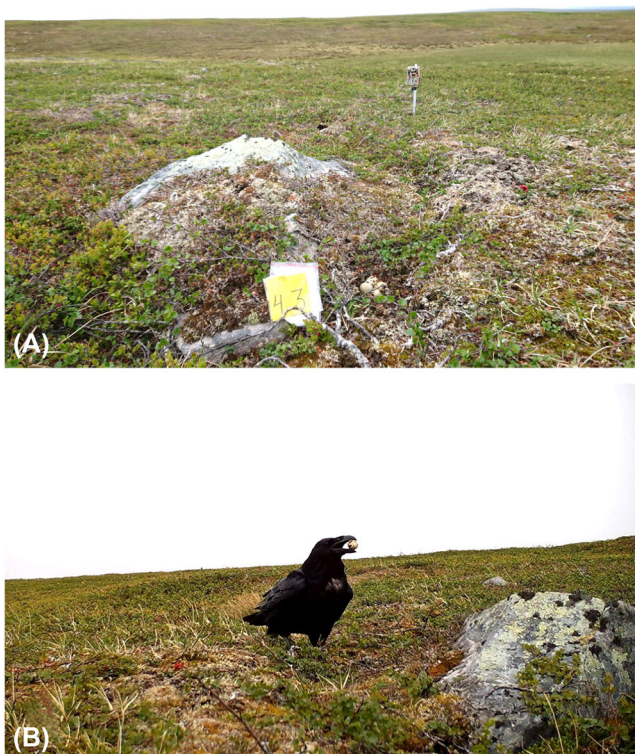


FIGURE 2 A) A wildlife camera mounted near an artificial nest and B) a predation event (i.e., visible egg removal) by a raven recorded at the same nest in northeastern Norway, 2018.

during egg deployment. We did this as an experimental treatment to assess if predation risk would decline when cameras did not immediately act as a cue for egg or nest presence. The nest sites were at the same location in the 2 years and had the same clutch size treatment and similar vegetation height.

The experiment started on 2 July and lasted until 16 July both years, yielding a 14-day exposure period. At the termination of the experimental periods, we recorded all remaining eggs in each nest. We checked all images from cameras manually. To describe the predator community, we identified a predation event when a predator could be seen to remove eggs from the nest and a predator incident as any visit to the nest by a nest predator regardless of whether eggs were removed or not. We used a binomial response of whether the nest lost any eggs to predators (0/1) for statistical analysis of predation rates. We recorded depredated nests as nest predation events (0/1) and used nest predation events as the entity in the statistical analyses. We were not able to relocate one nest without a camera in 2019, leaving 99 nests for estimation of predation rates.

Statistical analyses

We analyzed the data using generalized linear mixed-effects models (GLMM; package lme4; Bates et al. 2015) in the software R (R Development Core Team 2019), with a logit-link function applied to the binomial response variable that recorded predation or non-predation per experimental nests ($n = 99$). The predictions from this model are thus probabilities of predation over a 14-day exposure period. As potential fixed effects, we included as experimental factors the presence of a camera (yes or no), clutch size (4 or 8 eggs), vegetation height (cm), and year (2018 with deployment of nests simultaneous with the cameras or 2019 with a 2-day delay of deployment of the nest after the camera deployment). We used nest ID as a random factor in the analyses, thus taking into account the repeated censuses within the same nest sites over the 2 years.

Because almost all the nests with cameras were depredated, we refrained from fitting complex models (i.e., models with >2 predictor variables). This is because more complex models could be heavily influenced by accidentally aberrant predictor value combinations for the very few cases of nests with cameras that were not depredated. Consequently, we chose to follow a 2-stage modeling strategy. First, we modeled the binomial response for all nests as a function of the interaction between camera and year to assess the effect of what we considered to be the 2 most important experimental interventions (presence of cameras and year-specific deployment schedule). Second, for the subset of nests without cameras, which was more balanced with respect to response outcomes (almost equal frequencies of predation and no predation events), we modeled predation risk as functions of the 2 remaining predictor variables (vegetation height and clutch size).

We fit GLMMs using the Laplace approximation and the bobyqa optimizer in package lme4. We checked the models for constant variance of residuals, presence of outliers, and approximate normality of random effects. We deemed differences between levels of categorical experimental factors (e.g., camera effect) were statistically significant when 95% confidence intervals of odds ratios did not include 1.0, and assessed the significance of slope parameters of the continuous vegetation covariate using a Z-test.

RESULTS

In total, 75 of the 99 nests that we were able to relocate were depredated (36 in 2018 and 39 in 2019). Of the 60 nests with cameras, 56 (93.3%) were depredated. Four predator species were identified in camera photos, and ravens strongly dominated in terms of number of predator incidents and predation events (Figure 3). The dominance of birds—specifically corvids—as nest predators in the study region is consistent with previous studies using other methods for less-precise identification of predators (tracking plates, Ims et al. 2013b; plasticine eggs, Ims et al. 2019).

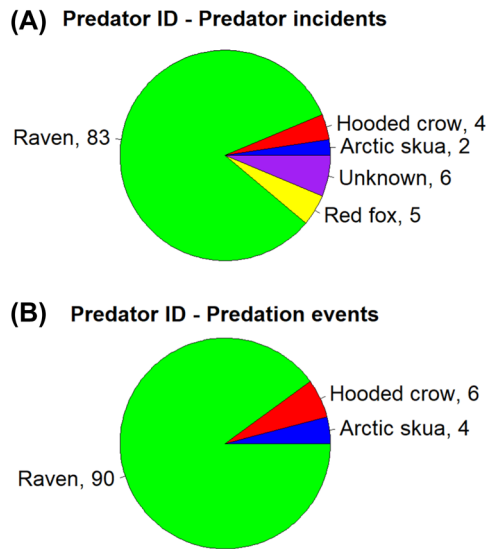


FIGURE 3 Distributions of the different nest predator species identified by images from cameras at experimental nests in northeastern Norway in 2018–2019. A) The percentage of incidents where the different predators were detected on nest cameras (total number of incidents = 126). B) The percentage of visible predation events (egg removal) among the different predator species (total number of events = 50). The predator incidents incorporate multiple visits to the same nest by the same or different predators and where egg removals were not necessarily observed, while predation events were predator incidents where egg removal was observed. Numbers behind the species names denote their percentage of the distributions.

The GLMM with the camera \times year interaction yielded predicted predation probabilities of 0.98 (95% CI = [0.75, 1]) for nests with cameras in both years in comparison to 0.33 (95% CI = [0.10, 0.70]) in 2018 and 0.65 (95% CI = [0.28, 0.90]) in 2019 for nests without cameras (Figure 4A). The size of the camera-treatment effect differed between the 2 years (larger in 2018 than in 2019), but the difference between nests with and without cameras remained statistically significant even in 2019 (odds ratio = 10.18, 95% CI = [2.15, 75.01]).

As expected, increasing vegetation had a negative effect on predation rate on nests without cameras (slope parameter = -1.15 , SE = 0.61, $Z = -1.89$, $P = 0.059$; Figure 4B), ranging from a predicted probability of 0.02 (95% CI = [0.00, 0.56]) at nest sites surrounded by 60-cm-high vegetation to a probability of 0.74 (95% CI = [0.43, 0.91]) at nest sites with no erect vegetation. Clutch size (8 eggs: 0.41, 95% CI = [0.18, 0.68]; 4 eggs: 0.52, 95% CI = [0.25, 0.78]) did not have an effect on predation rates for nests without cameras.

We identified common raven, hooded crow (*Corvus cornix*), and Arctic skua (*Stercorarius parasiticus*) as nest predators, which accounted for 90%, 6%, and 4% of predation events, respectively (Figure 3). Red foxes (*Vulpes vulpes*) were the only potential mammalian nest predator detected in camera images. They were observed at nests in 5% of pictures with animals; however, these visits were after nests were already depredated. During the 2 days prior to egg deployment in 2019, ravens were recorded at 7 of the 30 nest sites with cameras. The first recorded predation event on nests with cameras happened on average 1.4 days (range = 0–8) after the eggs were deployed (combined data from both years).

DISCUSSION

In this study, cameras as a visible structure near the nest seemed to attract the attention of nest predators, in particular ravens, inflicting near total predation of all experimental camera nests. Even nests with cameras well hidden in tall shrubs were found and depredated, while such nests without cameras had very low risks of being

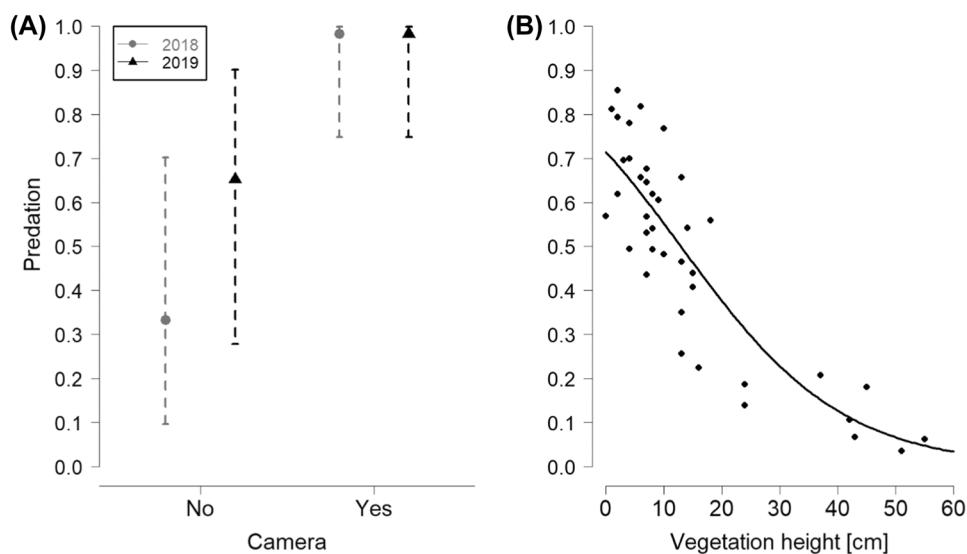


FIGURE 4 Predicted predation probabilities from the generalized linear mixed effects models of predation of artificial nests in northeastern Norway in 2018–2019. A) Predation probabilities (95% CI) for nest with and without cameras for the 2 years of the experiment. B) Predation probabilities as a function of vegetation height for nests without cameras.

found by predators (Figure 4B). The near total predation of nests with cameras implies that none of the other conditions invoked in this experiment—neither experimental nor environmental—had any strong influence when a camera was present near the nest. That the cameras themselves acted as the attractant was also evident as ravens visited nest sites with cameras during the short period before the eggs were deployed in 2019 (on 7 of 30 nests).

We documented a response opposite of what would be expected if neophobia caused predators such as corvids to avoid nests associated with wildlife cameras, as seen in other ecosystems (Richardson et al. 2009, Bravo et al. 2020). It may be that predators with good learning skills such as corvids (Sonerud and Fjeld 1987) have learned to avoid novel artificial structures, especially in more human-dominated ecosystems where baited traps are (or recently have been) used to persecute predators. In more pristine ecosystems without such persecution, any new anthropogenic structures may signal availability of food subsidies (garbage) to generalist predators. Indeed, such subsidies are regarded as a key cause for the recent range expansion of generalist predators into tundra ecosystems (Ims et al. 2013a, Elmhagen et al. 2015, Sokolov et al. 2016, Gallant et al. 2020). In tundra ecosystems that are not (yet) dominated by generalist predators using visual cues to find nest (e.g., corvids), previous studies have not found any effect of wildlife cameras on nest predation rates (Liebezeit and Zack 2008, McKinnon and Bêty 2009). Hence, we attribute the camera-induced positive bias (i.e., strongly inflated predation rates) that we observed to the dominance of ravens that are little persecuted by humans in Arctic Scandinavia. Indeed, corvids are known to be extremely efficient nest predators with profound abilities to adapt rapidly to prevailing ecological and anthropogenic contexts (Marzluff and Angell 2005, Stien and Ims 2016).

RESEARCH IMPLICATIONS

While there has been a revolution in the application of commercially available trail (or wildlife) cameras in environmental research during the last decades (Burton et al. 2015, Steenweg et al. 2017), care must be taken when using this methodology in studies of nest predation. In this study, we documented a stronger camera-induced bias

and with an opposite sign than previously reported (Richardson et al. 2009, Bravo et al. 2020) that we attributed to the dominance of ravens in Arctic Scandinavia. Hence, we call for caution when implementing new technologies for monitoring species interactions (e.g., cameras) without proper prior testing regarding potential unforeseen effects on the monitored species. Moreover, to better understand the drivers of increasing nest predation rates in barren environments such as Arctic tundra, there is a need to employ photographic devices that can be better concealed than conventional wildlife cameras. Specifically, we think that tailor-made, miniature cameras (Cox et al. 2012) placed on the ground, covered by prostrate tundra vegetation or substrate (e.g., small stones or gravel), could provide an adequate solution. However, even such improved devices need to be assessed with respect to potential effects on nest predation in each case.

ACKNOWLEDGMENTS

This paper is a contribution from COAT - Climate-ecological Observatory for Arctic Tundra. We thank the Research Council of Norway, Tromsø Research Foundation, and the Regional Research Fund of North Norway for financial support. Jan Erik Knutsen, Andrea Mel, and Pedro Nicolau provided valuable assistance in the field.

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have influenced the work reported in this paper.

ETHICS STATEMENT

This study adhered to the minimizing environmental footprint principle of Climate-ecological Observatory for Arctic Tundra (www.COAT.no). The use of artificial nests enabled us to test camera effects without inflicting negative impacts on native breeding birds in the study area.

DATA AVAILABILITY STATEMENT

The data set subjected to the statistical analysis, R code for the implementation of the GLMM, and the derived estimates of predation risk reported in this paper is provided in the data repository of the University of Tromsø (DataverseNO, UiT Open Research Data, <https://doi.org/10.18710/RZPKSG>).

ORCID

John-André Henden  <http://orcid.org/0000-0002-8825-1167>

REFERENCES

- Bates, D., M. Mächler, B. Bolker, and S. Walker. 2015. Fitting linear mixed-effects models using lme4. *Journal of Statistical Software* 67:1–48.
- Bravo, C., O. Pays, M. Sarasa, and V. Bretagnolle. 2020. Revisiting an old question: which predators eat eggs of ground-nesting birds in farmland landscapes? *Science of the Total Environment* 744:140895.
- Bravo, C., M. Sarasa, V. Bretagnolle, and O. Pays. 2022. Detectability and predator strategy affect egg depredation rates: implications for mitigating nest depredation in farmlands. *Science of the Total Environment* 829:154558.
- Burton, A. C., E. Neilson, D. Moreira, A. Ladle, R. Steenweg, J. T. Fisher, E. Bayne, and S. Boutin. 2015. Wildlife camera trapping: a review and recommendations for linking surveys to ecological processes. *Journal of Applied Ecology* 52:675–685.
- Cox, W. A., M. S. Pruett, T. J. Benson, S. J. Chiavacci, and F. R. Thompson III. 2012. Development of camera technology for monitoring nests. Pages 185–210 in C. A. Ribic, F. R. Thompson III, and P. J. Pietz, editors. *Video surveillance of nesting birds*. Studies in Avian Biology (no 43). University of California Press, Berkeley, USA.
- Elmhagen, B., J. Kindberg, P. Hellström, and A. Angerbjörn. 2015. A boreal invasion in response to climate change? Range shifts and community effects in the borderland between forest and tundra. *Ambio* 44:39–50.
- Faaborg, J. 2010. Suitability of artificial nests. *Science* 328:46.
- Gallant, D., N. Lecomte, and D. Berteaux. 2020. Disentangling the relative influences of global drivers of change in biodiversity: a study of the twentieth-century red fox expansion into the Canadian Arctic. *Journal of Animal Ecology* 89:565–576.

- Henden, J.-A., A. Stien, B.-J. Bårdsen, N. G. Yoccoz, and R. A. Ims. 2014. Community-wide mesocarnivore response to partial ungulate migration. *Journal of Applied Ecology* 51:1525–1533.
- Henden, J.-A., N. G. Yoccoz, R. A. Ims, and K. Langeland. 2013. How spatial variation in areal extent and configuration of labile vegetation states affect the riparian bird community in Arctic tundra. *PLoS ONE* 8:e63312.
- Hunt, K. L., D. Gibson, M. J. Friedrich, C. J. Huber, J. D. Fraser, S. M. Karpanty, and D. H. Catlin. 2020. Using nest captures and video cameras to estimate survival and abundance of breeding piping plovers *Charadrius melodus*. *Ibis* 162: 1–12.
- Ims, R. A., D. Ehrlich, B. C. Forbes, B. Huntley, D. A. Walker, P. A. Wookey, D. Berteaux, U. S. Bhatt, K. A. Bråthen, M. E. Edwards, et al. 2013a. Terrestrial ecosystems. In *Arctic Biodiversity assessment: status and trends in Arctic biodiversity* (pp. 385–440). Conservation of Arctic Flora and Fauna, Akureyri, Iceland.
- Ims, R. A., and J.-A. Henden. 2012. Collapse of an arctic bird community resulting from ungulate-induced loss of erect shrubs. *Biological Conservation* 149:2–5.
- Ims, R. A., J.-A. Henden, M. A. Strømeng, A. V. Thingnes, M. J. Garmo, and J. U. Jepsen. 2019. Arctic greening and bird nest predation risk across tundra ecotones. *Nature Climate Change* 9:607–610.
- Ims, R. A., J.-A. Henden, A. V. Thingnes, and S. T. Killengreen. 2013b. Indirect food web interactions mediated by predator–rodent dynamics: relative roles of lemmings and voles. *Biology Letters* 9:1–4.
- Ims, R. A., S. T. Killengreen, D. Ehrlich, Ø. Flagstad, S. Hamel, J.-A. Henden, I. Jensvoll, and N. G. Yoccoz. 2017. Ecosystem drivers of an Arctic fox population at the western fringe of the Eurasian Arctic. *Polar Research* 36:1–12.
- Killengreen, S. T., E. Strømeng, N. G. Yoccoz, and R. A. Ims. 2012. How ecological neighbourhoods influence the structure of the scavenger guild in low arctic tundra. *Diversity and Distributions* 18:563–574.
- Kubelka, V., M. Šálek, P. Tomkovich, Z. Végvári, R. P. Robert P. Freckleton, and T. Székely. 2018. Global pattern of nest predation is disrupted by climate change in shorebirds. *Science* 362:680–683.
- Laidlaw, R. A., T. G. Gunnarsson, V. Méndez, C. Carneiro, B. Pórisson, A. Wentworth, J. A. Gill, and J. A. Alves. 2020. Vegetation structure influences predation rates of early nests in subarctic breeding waders. *Ibis* 162: 1225–1236.
- Lehikoinen, A., L. Brotons, J. Calladine, T. Campedelli, V. Escandell, J. Flousek, C. Grueneberg, F. Haas, S. Harris, S. Herrando, et al. 2019. Declining population trends of European mountain birds. *Global Change Biology* 25:577–588.
- Lehikoinen, A., M. Green, M. Husby, J. A. Kålås, and Å. Lindström. 2014. Common montane birds are declining in northern Europe. *Journal of Avian Biology* 45:3–14.
- Liebezeit, J. R., and S. Zack. 2008. Point counts underestimate the importance of Arctic foxes as avian nest predators: evidence from remote video cameras in Arctic Alaskan oil fields. *Arctic* 61:153–161.
- Marzluff, J. M., and T. Angell. 2005. In the company of crows and ravens. Yale University Press, New Haven, Connecticut, USA.
- McKinnon, L., and J. Bêty. 2009. Effect of camera monitoring on survival rates of High-Arctic shorebird nests. *Journal of Field Ornithology* 80:280–288.
- McKinnon, L., P. A. Smith, E. Nol, J. L. Martin, F. I. Doyle, K. F. Abraham, H. G. Gilchrist, R. I. G. Morrison, and J. Bêty. 2010a. Lower predation risk for migratory birds at high latitudes. *Science* 327:326–327.
- McKinnon, L., P. A. Smith, E. Nol, J. L. Martin, F. I. Doyle, K. F. Abraham, H. G. Gilchrist, R. I. G. Morrison, and J. Bêty. 2010b. Suitability of artificial nests—response. *Science* 328:46–47.
- McMahon, B. J., S. Doyle, A. Gray, S. B. A. Kelly, and S. M. Redpath. 2020. European bird declines: Do we need to rethink approaches to the management of abundant generalist predators? *Journal of Applied Ecology* 57:1885–1890.
- Pedersen, Å. Ø., J. U. Jepsen, I. M. G. Paulsen, E. Fuglei, J. Mosbacher, V. Ravolainen, N. G. Yoccoz, E. Øseth, H. Böhner, K. A. Bråthen, et al. 2021. Panel-based assessment of ecosystem condition of Norwegian Arctic tundra. *Framsenteret, Tromsø, Norway*.
- R Development Core Team. 2019. R: a language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.
- Rao, X., J. Li, B. He, H. Wang, G. Wu, T. Teng, and Q. Ling. 2023. Nesting success and potential nest predators of the red junglefowl (*Gallus gallus jabouillei*) based on camera traps and artificial nest experiments. *Frontiers in Ecology and Evolution* 11:1127139.
- Ribeiro-Silva, L., D. F. Perrella, C. H. Biagolini Jr. P. V. Q. Zima, A. J. Piratelli, M. N. Schlindwein, P. M. Galetti Jr. and M. R. Francisco. 2018. Testing camera traps as a potential tool for detecting nest predation of birds in a tropical rainforest environment. *Zoologia* 35:1–8.
- Richardson, T. W., T. Gardali, and S. H. Jenkins. 2009. Review and meta-analysis of camera effects on avian nest success. *Journal of Wildlife Management* 73:287–293.
- Roos, S., J. Smart, D. W. Gibbons, and J. D. Wilson. 2018. A review of predation as a limiting factor for bird populations in mesopredator-rich landscapes: a case study of the UK. *Biological Reviews* 93:1915–1937.
- Salewski, V., and L. Schmidt. 2022. Nest cameras do not affect nest survival in a meadow-nesting shorebird. *Bird Conservation International* 32:127–136.

- Soininen, E. M., J.-A. Henden, V. T. Ravolainen, N. G. Yoccoz, K. A. Bråthen, S. T. Killengreen, and R. A. Ims. 2018. Transferability of biotic interactions: temporal consistency of arctic plant–rodent relationships is poor. *Ecology and Evolution* 8:9697–9711.
- Sokolov, A. A., N. A. Sokolova, R. A. Ims, L. Brucker, and D. Ehrich. 2016. Emergent rainy winter warm spells may promote boreal predator expansion into the Arctic. *Arctic* 69:121–129.
- Sonerud, G. A., and P. E. Fjeld. 1987. Long-term memory in egg predators: an experiment with a hooded crow. *Ornis Scandinavica (Scandinavian Journal of Ornithology)* 18:323–325.
- Steenweg, R., M. Hebblewhite, R. Kays, J. Ahumada, J. T. Fisher, C. Burton, S. E. Townsend, C. Carbone, J. M. Rowcliffe, J. Whittington, et al. 2017. Scaling-up camera traps: monitoring the planet's biodiversity with networks of remote sensors. *Frontiers in Ecology and the Environment* 15:26–34.
- Stien, J., and R. A. Ims. 2016. Absence from the nest due to human disturbance induces higher nest predation risk than natural recesses in common eiders *Somateria mollissima*. *Ibis* 158:249–260.
- Young, K. G., L. V. Kennedy, P. A. Smith, and E. Nol. 2021. Testing whether camera presence influences habitat specific predation pressure on artificial shorebird nests in the Arctic. *Arctic* 74:22–29.

Associate Editor: David King.

How to cite this article: Henden, J.-A., R. A. Ims, and M. A. Strømeng. 2025. Trail cameras can greatly inflate nest predation rates. *Journal of Wildlife Management* 89:e22684. <https://doi.org/10.1002/jwmg.22684>