

Predator Monitoring Survey within Kinveachy Forest Special Protection Area.

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Background:

Strathspey is now the stronghold for capercaillie in Scotland, estimated to hold 83% of the estimated population (Wilkinson *et al.* 2018). The main cause of the decline of capercaillie since 1970s has been low breeding success, exacerbated by deaths of adults from deer fence collisions (Moss *et al.* 2000, Baines & Summers 1997). Although many fences have now been removed or marked, breeding success remains low compared to elsewhere in the species' range (Moss *et al.* 2000, Jahren *et al.* 2016).

An analysis of breeding success from forests across Scotland between 1991 and 2009 highlighted that females reared more chicks in years when hatch time in June was drier, and in forests with lower pine marten and carrion crow indices. In addition, more females reared broods in years when Aprils were cooler. Densities of adult birds were also found to be lower in forests with higher fox indices (Baines *et al.* 2016). As part of this study the spring predator transect surveys undertaken 14 years apart showed an increase in indices of foxes (2.2 fold) and pine martens (3.9 fold), but no change in crows and raptors across 11 Scottish forests (Baines *et al.* 2016).

Kinveachy Forest Special Protection Area (SPA) has been designated by Nature Scot (previously Scottish Natural Heritage) as "it is one of the major tracts of remnant Caledonian forest in Strathspey and is the third largest pinewood in the region" (www.sac.jncc.gov.uk/site/UK0012759). As such, it is a vital forest within Strathspey for breeding capercaillie. In addition to the monitoring of capercaillie leks and breeding success the estate support studies of other factors that may affect capercaillie, such as generalist predators. Previous predator monitoring on the estate as part of Game & Wildlife Conservation Trust (GWCT) projects has included scat surveys, hair tube surveys (collecting DNA to identify individual pine martens) and baited trail camera surveys.

The Carrbridge Capercaillie Conservation Strategy identified a perception within the community that predators are a moderately important to very important threat to capercaillie. When asked if reducing predators should occur before any restrictions are placed on people, on average, respondents slightly disagreed with the statement, but responses varied. There were also differences in opinion regarding predator management depending on the species being considered. To provide more information on the current mammalian predator activity levels for the Carrbridge Capercaillie Group we repeated the winter 2014 trail camera survey within the Kinveachy core capercaillie monitoring area.

Methods:

An area of 11 km² within the Kinveachy Forest SPA has been monitored annually for capercaillie breeding success (1994-2020). The count area used for this activity was divided up into 500 m x 500 m cells overlaying the Ordnance Survey 1km² grid. The grid ensures the cameras are spread out with no more than one camera within a cell with at least 200 m between any two cameras. All cameras were positioned following the same protocol i) cameras placed on nearest tree to a path, animal trail or running water, ii) canopy cover was essential so open ground/clearing of forest were avoided, iii) crunchy peanut butter was used as bait, placed off the ground on tree stump, rock or fallen tree at a distance of 1 - 3 m from the camera (see photos in Figure 1).

When the survey was undertaken in 2014 twelve cameras were available. These were initially set up from 3rd November 2014 until 28 November 2014 and then ten cameras were moved to new cells from 28 November 2014 until 3rd December 2014, when heavy snow fall curtailed survey efforts. This meant that cameras covered 22 of the 500 x 500 m cells (Figure 2) providing data from a total of 324 trap-nights with average of 15 trap-nights per camera (range 5 – 25 trap-nights). Cameras were visited approximately weekly to replace the batteries, memory card and bait if necessary.



Figure 1. Photos of camera locations and bait application.

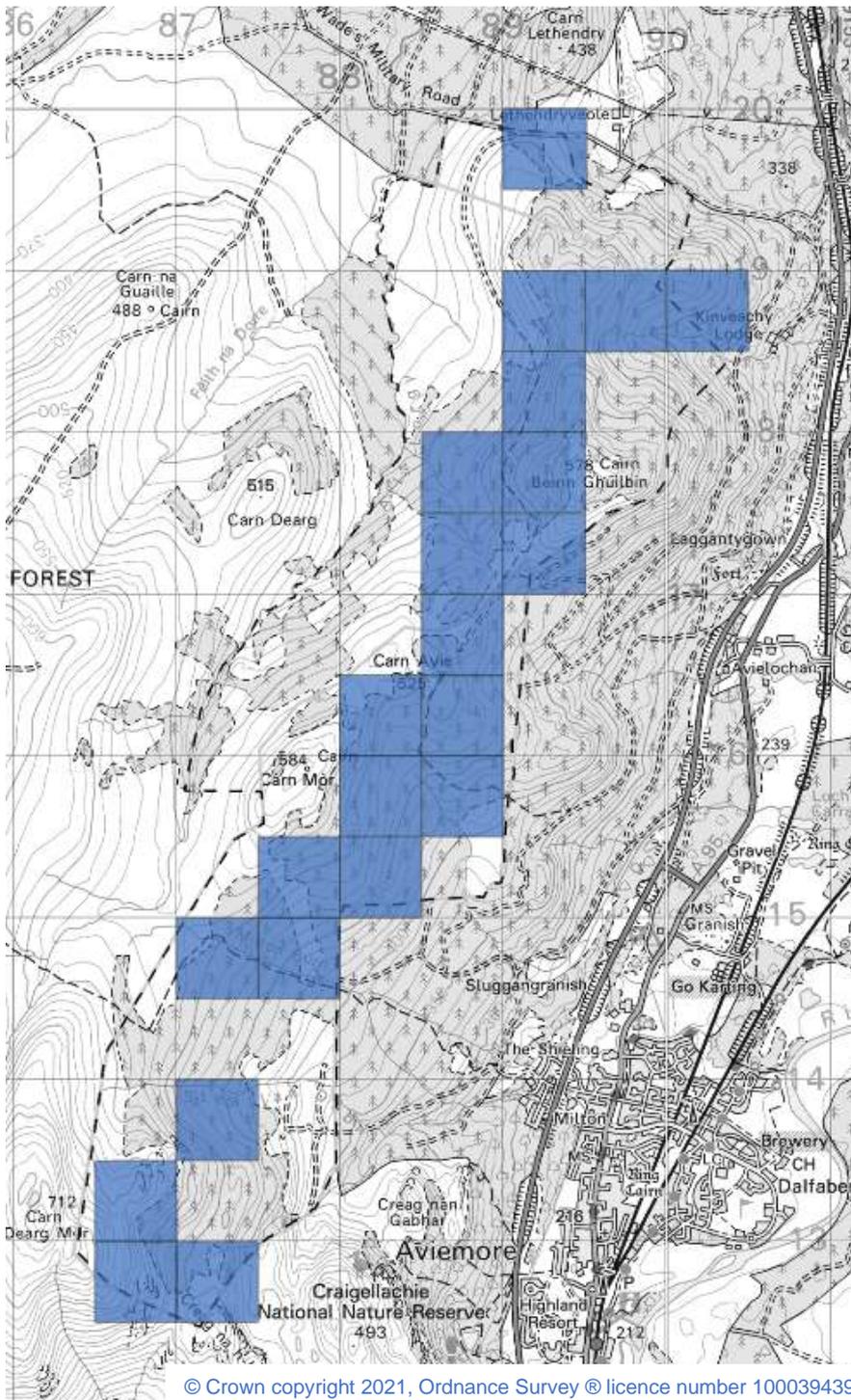


Figure 2. Trail camera cells within Kinveachy Forest SPA monitored in 2014 and 2020 (blue), with capercaillie brood count area illustrated as dotted line.

Thirty-two cameras were available from GWCT and the Cairngorm Capercaillie Project in 2020 (models: Spy Point Force 11D, Browning Recon Force BT-7A and Acorn Ltl 5210A). The cameras were positioned in the same 22 cells as 2014 (following the same protocol) plus an additional 10 cells (see Appendix). In 2020 the cameras were put out from 17th to 20th November 2020. To maximise the variation in weather conditions encountered they remained in the same cells until 5th

to 7th January 2021. The first two checks were at two-week intervals (when bait was reapplied if necessary) and the final check was after three weeks. This provided a total of 1448 trap-nights with average of 45 trap-nights per camera (range 23 – 52 trap-nights). The results from all cameras and the full time period are provided in the Appendix. For a direct comparison with the 2014 data, we have only considered those cameras in the same cells as used in 2014. We also only included images recorded during the first week after baiting (three weeks for 12 cells, and one week for the remaining 10 cells to replicate the 2014 survey). This provided a total of 322 trap-nights with an average of 15 trap-nights per camera (range 7 – 21 trap-nights).

The cameras were programmed to record 24 hours. When triggered, three images were recorded to make identification easier and the interval between triggers was set at 5 minutes to avoid too many images of the same individual. The images were all examined and the number of encounters were calculated (three images from the same trigger = one encounter). Our focus was on identifying images of mammalian predators (pine marten, fox and badger) and comparing the 2014 and 2020 surveys. Sightings of other mammals / birds from the 2020 survey are included in the Appendix.

Results:

Pine martens were recorded in both 2014 and 2020 (Figure 3 illustrates typical images of pine martens). In 2014 pine martens were recorded in 15 out of the 22 cells (68%). Occupancy was significantly lower in 2020 with 6 out of 22 cells (27%) recording pine martens ($\chi^2_1 = 7.4, P = 0.007$). As illustrated in Figure 4 there were five cells with pine martens in both years, six cells where they were absent in both years, 10 cells where they were only record in 2014 and a single cell where they were only recorded in 2020.



Figure 3. Typical images captured of pine martens.

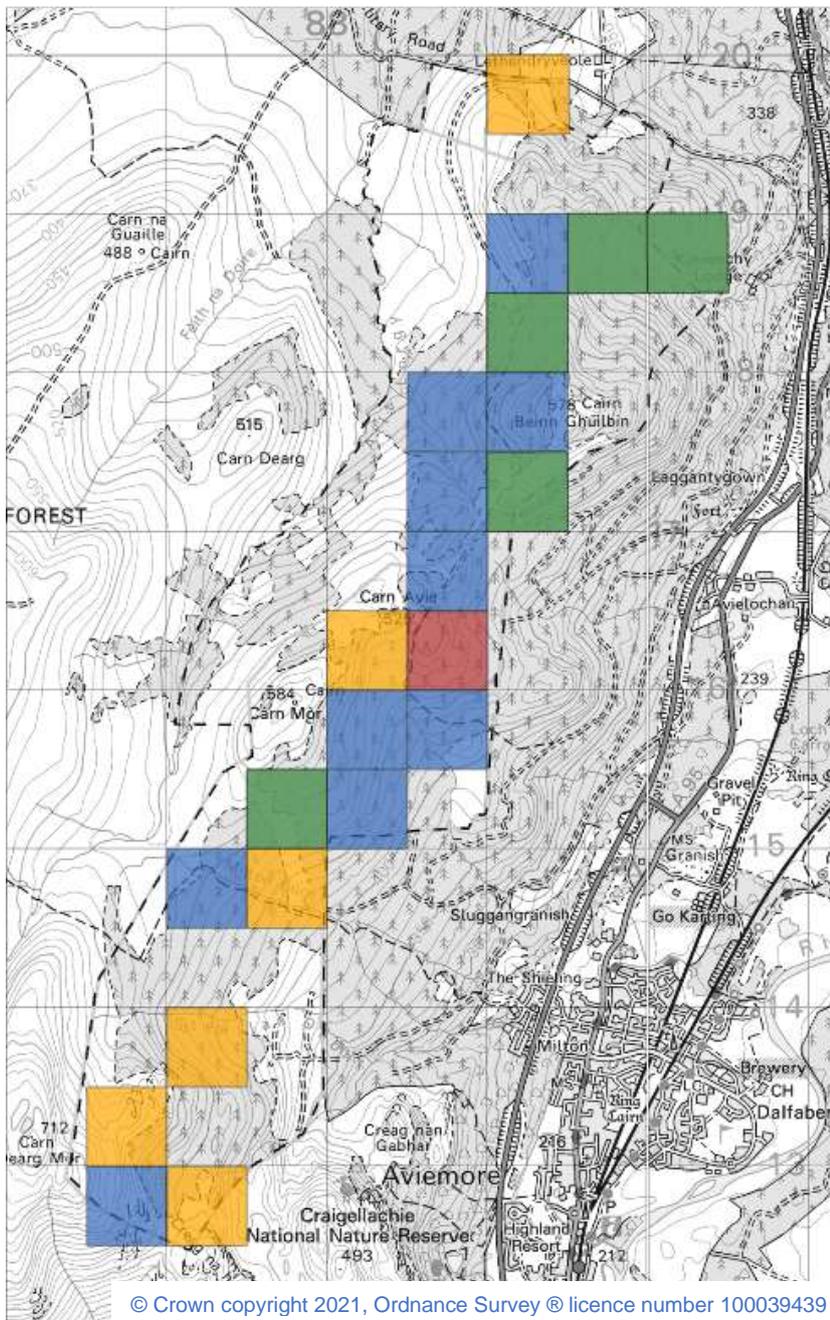


Figure 4. 500 m x 500 m cells monitored with trail cameras in 2014 and 2020. Green = pine martens present in both years; blue = present in 2014, but not 2020; red = absent in 2014, present in 2020; orange = absent in both years.

In 2014 56 encounters of pine marten were recorded over 324 trap-nights (0.17 encounters per trap-night). This activity level was lower in 2020 with 17 encounters over 322 trap-nights (0.05 encounters per trap-night: Wilcoxon Matched-Pairs Test, $W = 12.5$, $P = 0.002$). The activity level (encounters per trap-night) at each camera is shown in Figure 5. Each survey shows similar levels of activity above (west) of Kinveachy Lodge. In 2020 there were lower levels of activity south-west of Beinn Ghuilbin and within the northern half of the Native Pinewood Scheme area than recorded in 2014. Few encounters were recorded in either year at the southern end of the Native Pinewood Scheme area and within Lady Seafield Plantation at the north end of the study area.

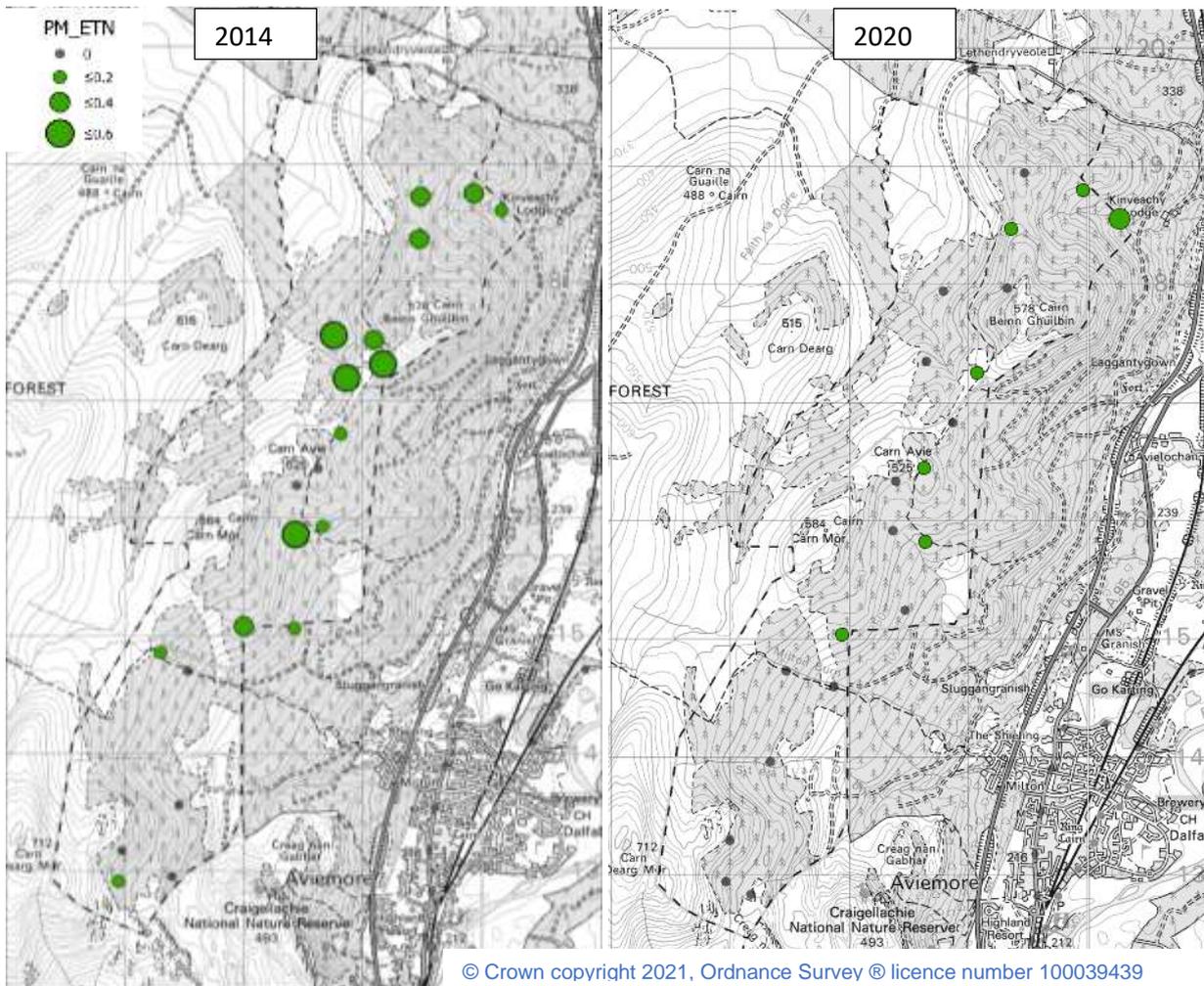


Figure 5. Map of 2014 (left) and 2020 (right) encounters per trap-night for pine martens. For both maps the grey dots show no pine martens recorded and the green dots show pine marten encounters ranging from 0.1 to 0.6 encounters per trap-night as shown in the legend.

In 2020 the date / time was recorded for 30 encounters across the whole survey (for the remaining eight encounters the date / time had frozen or reset). None of the encounters were less than three hours before / after any other encounter, so the same individual being recorded on different cameras could not be ruled out. As expected, all pine marten encounters were between 17:14 and 07:56 (avoiding daylight) with 60% of the encounters after midnight (Figure 6).

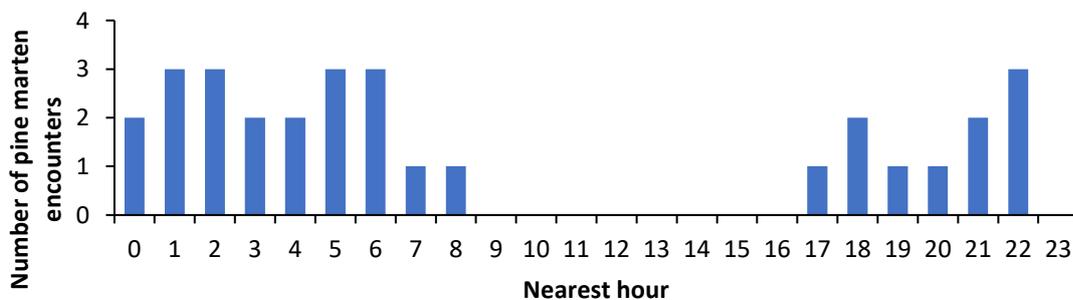


Figure 6. Number of pine marten encounters recorded during 24-hour cycle.

In 2014 two encounters of foxes were recorded (0.006 encounter per trap night; 9% of cells) but no badgers were recorded. In 2020 neither foxes nor badgers were recorded.

Discussion:

It is particularly difficult to estimate abundance and distribution of secretive and nocturnal mammals, especially if they occur in low densities and in forests (Carbone *et al.* 2001). For species that are easy to identify individually, camera traps have been widely used to estimate population density applying capture–recapture models (e.g. Karanth & Nichols 1998, Anile *et al.* 2014, Paull *et al.* 2012). However, pine martens are considered difficult to visually identify individually from trail camera images (Manzo *et al.* 2012), although bib pattern can be used if enough suitable images are captured (Rosellini *et al.* 2008). When it is not possible to confidently distinguish individuals, relative abundance indices (RAI) are used (Carbone *et al.* 2001, Silveira, *et al.* 2003). The number of encounters per trap night provides a RAI or activity index. The same individuals may have been involved in multiple encounters and may also be recorded across different cameras. Radio-tracking studies in Bialowieza National Park, Poland found that individual pine martens have a daily range of 12 km² (Zalewski *et al.* 2004). A trail camera study in Montes do Invernadeiro Natural Park in northern Spain assumed different individuals were recorded if cameras were 1.3 km apart (collaborated by examining bib patterns) (Rosellini *et al.* 2008). These two studies demonstrate how home ranges are likely to vary with habitat quality and availability and may vary across the pine martens' European range (Birks 2002). Therefore, we have not made assumptions about numbers of individuals from the activity index collected in this survey.

The comparison of pine marten activity levels and distribution showed more activity in winter 2014 than in winter 2020. Pine martens are a generalist predator although small rodents are their staple prey, with a wider diet consumed in summer when small birds and fruits are available (Caryl *et al.* 2012). Small rodent populations are known to fluctuate with associated changes in predator abundance (e.g. Lambin *et al.* 2000, Korpela *et al.* 2014). The activity index for small rodents was lower in 2020 than reported in 2014 camera survey (Appendix), although we cannot rule out differences in camera sensitivity between surveys for these smaller mammals.

Foxes were only recorded in 2014 survey. Baiting with meat rather than peanut butter may be more appropriate to better detect fox activity. We would expect badgers to be attracted to peanut butter but none were recorded in either of these winter surveys.

This repeat survey suggests lower pine marten activity in winter 2020 than in winter 2014. Although spring / summer is the key period when pine marten presence may be impacting capercaillie breeding success and survival, this winter survey indicates the level of pine martens activity which would be present at the start of spring (before they breed).

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APPENDIX.

This appendix includes data collected for the full 2020 survey (including 10 additional cells it was not possible to monitor in 2014, Figure A).

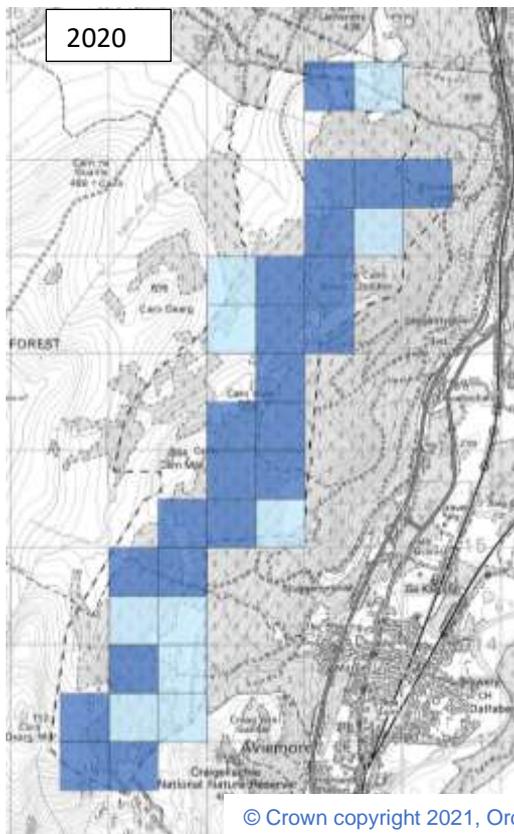
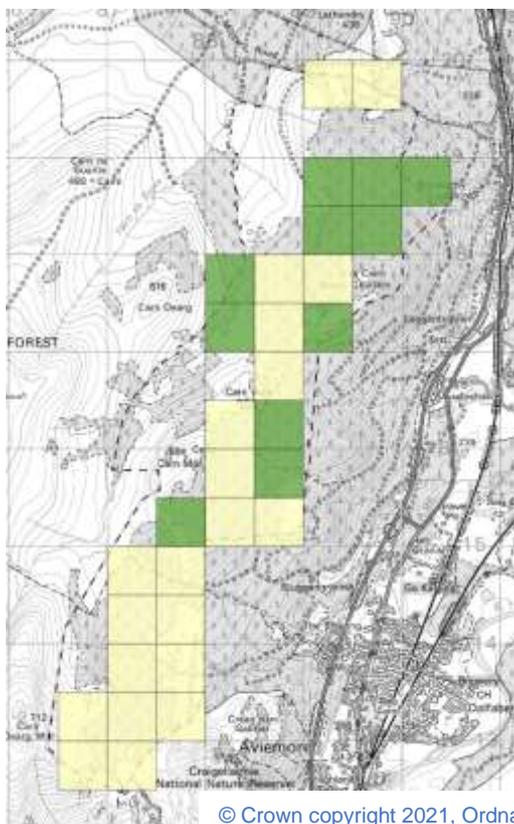


Figure A. Trail camera cells within Kinveachy Forest SPA monitored in 2014 and 2020 (dark blue) and 2020 only (light blue), with capercaillie brood count area illustrated as dotted line.



In addition to the pine marten encounters recorded in the core cells, the 2020 survey also found animals in the two cells near the Allt Lorgy Burn on west side of the study area (Figure B).

Using full dataset from 2020 (32 cells and 1448 trap-nights) there were 38 pine marten encounters in 11 cells (34% occupancy) and an activity level of 0.03 encounters per trap night.

Figure B. Map of all 500 x 500 m cells with cameras used in 2020 which recorded pine martens (green) and those which did not (yellow).

Non-predator sightings: In 2020 the trail cameras also recorded deer (red, roe and sika), small rodents, mountain hare, red squirrel, and birds (Table A). No capercaillie images were captured (as was the case in 2014). The deer activity was spread across the study area except within Lady Seafield Plantation at the north end (Figure D). The mountain hare (19% of cells) and red squirrel records (6% of cells) were less frequent and were not focussed on any particular part of the study area.

The small rodents were not recorded further south than the Milton Burn, which is a similar pattern to the pine martens. Across the whole study area 72% cells either recorded both pine marten and small rodent or neither and 28% recorded one or the other only in 2020. Using the abridged dataset as for predators to compare the two surveys, small mammal activity level was 0.35 encounters per trap night (18% of cells) in 2020 compared to 2.71 encounters per trap night (64% of cells) in 2014.

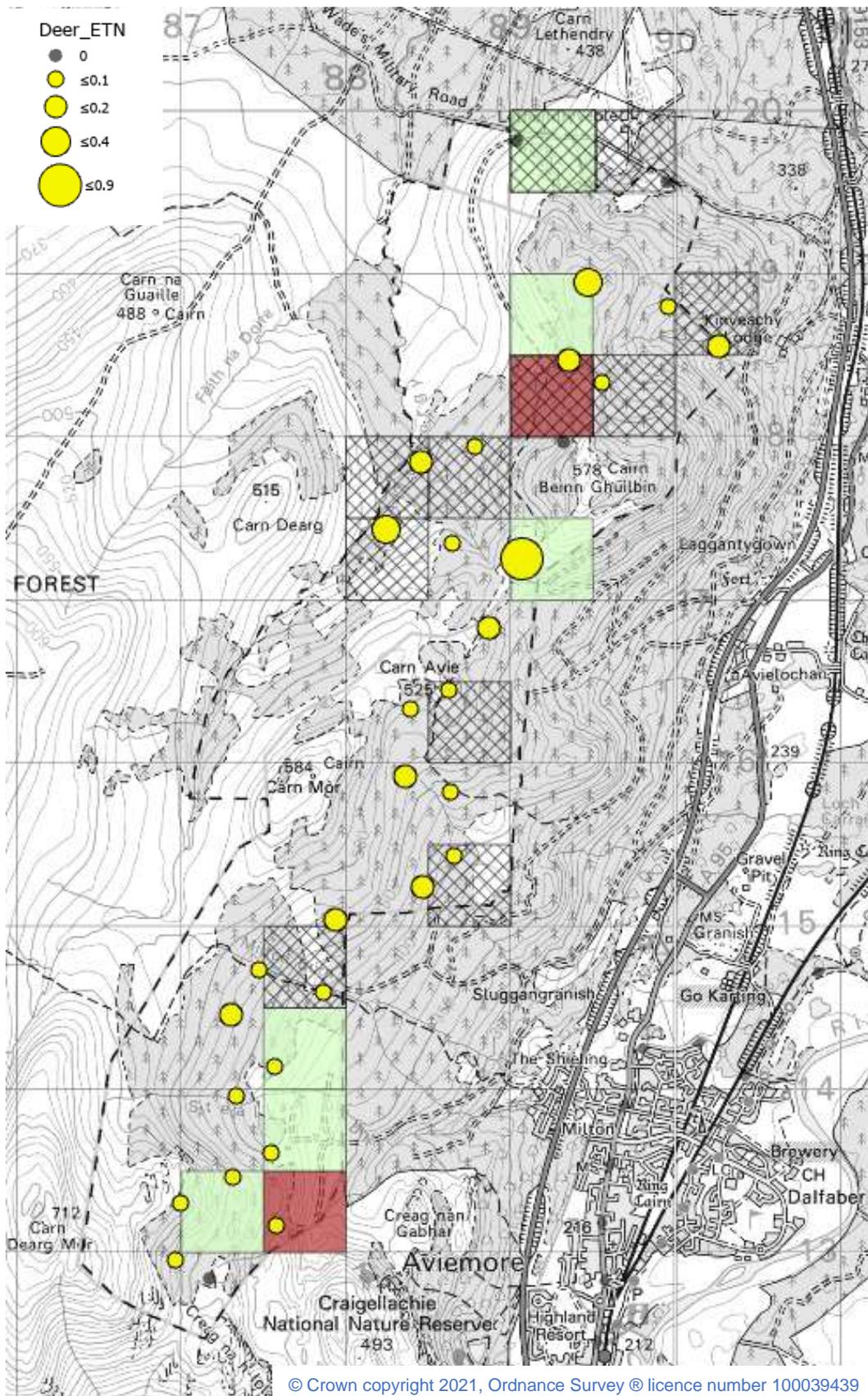
Human visitors to the forest were also recorded. The majority of the visitors were recorded walking on paths (92%), with 3 additional encounters (8%) of people walking away from tracks.

Table A. Other sightings recorded in 2020 (across 1448 trap-nights and 32 cells).

	Number Encounters	Number of cells (%)
Deer	148	28 (88%)
Small rodent	300	11 (34%)
Mountain hare	10	6 (19%)
Red squirrel	2	2 (6%)
Jay	37	5 (16%)
Blackbird	2	1 (3%)
Wren	1	1 (3%)
Human visitors	38	6 (19%)
Dogs	4	4 (13%)



Figure C. Typical images captured of (top left to right) jay, small rodent, mountain hare and (bottom) deer species.



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Figure D. Deer activity levels (yellow dots – see legend) and presence of mountain hare (pale green), red squirrel (red) and small rodents (hatched).