Resident Golden Eagle ranging behaviour before and after construction of a windfarm in Argyll

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Resident Golden Eagle ranging behaviour was monitored over 776 observation hours before and after construction of a windfarm in Argyll, western Scotland between 1997 and 2004. Overall size of the eagle range that was potentially affected by the windfarm (for male, female and both eagles) was similar before and after construction. Eagles appeared to change their ranging to avoid the windfarm site. Once built the windfarm was over flown mostly when other eagles intruded on the territory. An area of plantation forestry was felled with the aim of mitigating the potential loss of foraging habitat to the windfarm, and drawing eagles away from the windfarm thereby reducing collision risk. Eagles were seen in the tree cleared area 3 times more often after felling than before felling, and the shift in ranging was away from the windfarm and in the direction of the felled area. These findings are from a single pair and should be used cautiously when applied to other, similar, situations. However, they are an important first step in understanding the likely effects of windfarms on eagles.

Introduction

In the UK in 2004, 253 MW of new, wind generated electricity was added to the national grid, 5 times the annual amount in the 1990s and double the 2003 figure. In Scotland, 11 schemes are under construction and due to come on line by the end of 2005. Many more developments are being planned in Scotland, and 70% of onshore schemes being considered for planning approval in the UK are located there (British Wind Energy Association 2004). Prospecting for new, commercially viable sites continues.

Scotland holds virtually all breeding pairs of Golden Eagles *Aquila chrysaetos* in the United Kingdom. Windfarms located within the range of Golden Eagles can cause eagle deaths due to collisions (Hunt 2002), and it has been thought that eagles may alter their ranging behaviour to avoid turbines, thus rendering the habitat within the windfarm area unavailable to foraging eagles. In Scotland these possible impacts have led to the adoption of a cautious approach to the siting of windfarms with regards to the location of territorial eagles.

A 46 turbine windfarm, the Beinn an Tuirc windfarm, was constructed during 2001 within an occupied eagle territory in Argyll. In addition, another windfarm, the Deucheran Hills windfarm, was built in 2001 (9 turbines) about 6.4 km to the north of the Beinn an Tuirc site, and is more peripheral to the home range of the eagles. To mitigate the potential habitat loss resulting from the Beinn an Turic windfarm, a habitat management plan was implemented that included forest clearance and management of existing Heather (*Calluna vulgaris*) moorland to increase the abundance of potential eagle prey (eg Willow Ptarmigan *Lagopus lagopus scoticus* and Black Grouse *Tetrao tetrix*). The creation of new areas of foraging habitat away from the windfarm was also thought likely to reduce the risk of eagle collisions with the turbines. An on going programme of eagle monitoring was

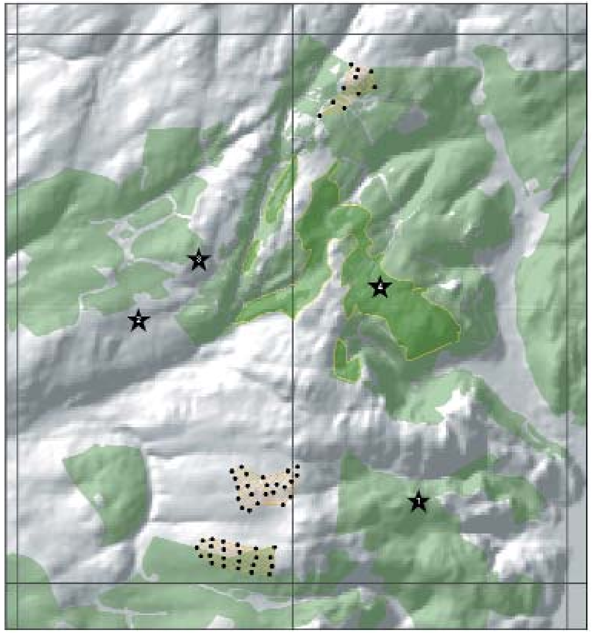


Figure 1 ***Study area. Grid lines are 5 km x 5 km.***

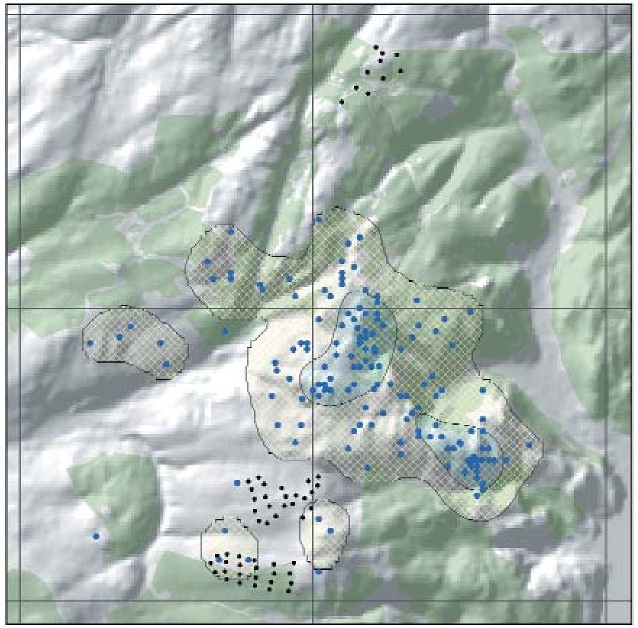


Figure 2 ***Kernel analysis of resident eagle movement (n=154) 1997-2004.***

undertaken from 1997 to assess effects of the Beinn an Tuirc windfarm and the habitat management plan on Golden Eagle ranging and breeding performance.

The Golden Eagle is a species of medium conservation concern in Britain (Gibbons *et al* 1996). In Argyll habitat changes that adversely influence foraging potential (eg upland afforestation and overgrazing of Heather areas) have affected territories adjacent to the one studied by us (Watson *et al* 1987). In spite of the similar loss of much land to plantation forest within the estimated eagle home range that includes the Beinn an Tuirc windfarm, there remains an extensive area of open land with modest populations of important prey species such as Willow Ptarmigan. Because of this the home range continues to be potentially viable for breeding eagles.

Study area

The Beinn an Tuirc windfarm (255 ha) and eagle monitoring area (ca 57 km^2) straddle the main ridge (Figure 1), which is generally below 300m above sea level, though there are peaks of ca 450m. The eastern slopes of this ridge, to a distance of about 3 km, are characterized by deeply cut valleys, with rock outcrops that provide a number of suitable eagle nest sites. To the west of the main ridge for a distance of about 8 km the terrain is gentler, characterized by wide, rounded ridges and shallow incised stream courses that run to the sea. This east west pattern extends both north and south of the study area.

Landcover within the monitoring area includes commercial forestry blocks, mostly Sitka Spruce *Picea sitchensis* of varying age, and open hill, dominated by grass and Heather; open areas include both grazed and ungrazed habitats, which are mostly acidic grasslands with some areas of shrub heath and areas of blanket bog on the higher slopes. Between October 1999 and June 2001 an area of forest (ca 280 ha) was felled to the north east of the main open area as part of the habitat management plan. Eagle monitoring focused on an area of ca 34 km^2 of open hill, which is bounded on the north and south by forest, but also includes ca 7 km^2 of open ridges within forest blocks to the north.

The diversity of natural fauna is limited, and a number of species, such as Mountain Hare *Lepus timidus* and Golden Plover *Pluvialis apricaria*, no longer occur locally as breeders. Mammals include small numbers of Rabbits *Oryctolagus cuniculus* around the fringe of the monitoring area, occasional Brown Hares *Lepus europaeus* towards its western edge, Sika *Cervus nippon* and Roe *Capreolus capreolus* Deer in the plantations and Foxes *Vulpes vulpes*. The birds are typical of upland areas in western Scotland (Ratcliffe 1990). Birds breeding on or using the area include diurnal and nocturnal raptors, Red-throated Divers *Gavia stellata*, small numbers of Mallard *Anas platyrhynchos*, Eurasian Teal *A. crecca* and Mew Gulls *Larus canus*. The forest avifauna is dominated by passerines such as European Robin *Erithacus rubecula* and Chaffinch *Fringella coelebs*, and corvids *Corvus* spp. Black Grouse are present in 3 to 4 areas of the younger plantations, but also occur on the open hill. The open hill holds a scattered population of Willow Ptarmigan, which are mostly associated with areas of Heather moorland. Small numbers of Common Snipe *Gallinago gallinago* and Eurasian Curlew *Numenius arquata* occur in grass dominated wet flushes.

The Beinn an Tuirc windfarm contains 46 – 660kW turbines that are divided evenly into 2 groups (north and south); within these groups the turbines are > 150 m apart. At its narrowest point the gap between the north and south areas is about 670 m. The Beinn an Tuirc windfarm itself is located in the central southern section of the

main block of open area with plantation forestry bordering its southern edge. Some plantation forestry (ca 50 ha) was removed to accommodate the southern section of the windfarm.

Human activity in the study area prior to windfarm construction mostly comprised shepherding on the open hill, deer stalking within the forests and ecological project survey work throughout the area. Forest operations, eg felling and planting, are ongoing, but the location, timing and extent of these are controlled, especially during the breeding season, to lessen potential impact on the eagles. Since construction, regular maintenance of the wind turbines has been added to the list of human activities in the area. Human visitor pressure on the open hill by hill walkers, both before and after construction, was very limited and mostly associated with accessing the highest summit.

Methods

Observations of eagle movements were made from 4 vantage points (VP). From these we monitored range occupancy, habitat use and foraging effort by the individual eagles, and collected information on eagle behaviour. Two VPs have been in use since 1997, a third was added in 1998 and a fourth in 1999. The Beinn an Tuirc windfarm area and main open area have been monitored since 1997; the addition of the last 2 VPs allowed us a better view of an area of forestry felled in mitigation of the windfarm. Collectively, the area viewed from the VPs comprises the eagle monitoring area, and VPs are located around the perimeter of this area so that the greatest continuous panorama is under observation, while reducing any potential influence of observer presence on eagle behaviour.

Observations were made 8 times per year (twice per quarter) from each VP between November 1997 and April 2004 except during March to December 2001, when fieldwork was curtailed by Foot and Mouth Disease access restrictions. Within each quarter all 4 VPs were visited; the order of visits was arbitrary. Weather could affect the area viewed from any particular VP and the duration of any particular watch period. Observation periods were chosen to avoid periods of continuous heavy rain, snow or dense fog, and ideally were 4 hours in length. Where possible, watches affected by poor weather conditions were extended to achieve 4 hours of observation time. While weather conditions could affect VP visibility they did not influence choice of VP, and all VPs were visited in a variety of conditions. While most watches tended to cover the middle of the daylight period, observations occurred at all times of the day. A total of 392 hrs of observation were made before construction, 68 during construction and 316 hrs after construction.

A single, experienced observer (DW) made all observations. The viewing area was kept under continuous observation for the full watch period by above skyline scanning without optical aids, binocular scanning of all areas and regular telescopic checks of known and potential perches. In so doing bias in observer effort towards specific locations within the viewing field was minimized.

When an eagle was seen, the time of first contact was recorded to the nearest second, and the bird's flight path was plotted on a paper map. Simple flights were synchronously plotted in the field, prolonged flights were plotted in sections that were drawn synchronously or nearly so, and fast or short flights were plotted immediately after they occurred. Final plotting of more complex flight lines was completed as soon as was possible after the watch period. In this way a complete activity log of eagle behaviour and location was kept for each VP session. An estimation of altitude above the ground (in range

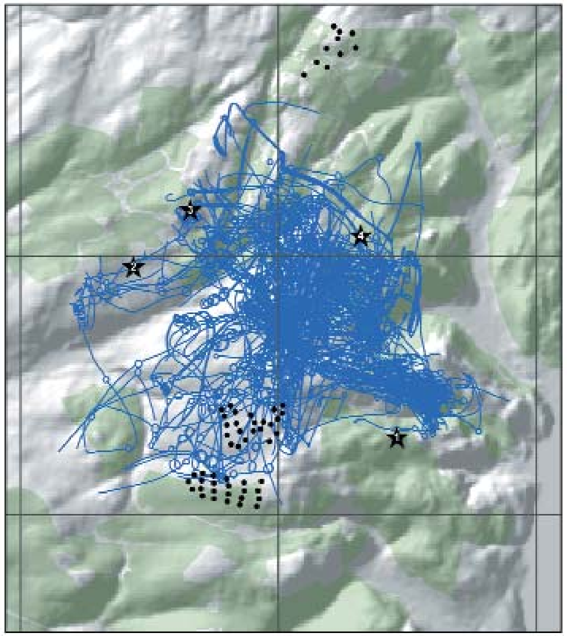


Figure 3 *Flight lines (left, n=811) of resident Golden Eagles (male and female). Grid (1 km²) colour shows relative use by eagles (dark red=heavy use, light pink=light use).*

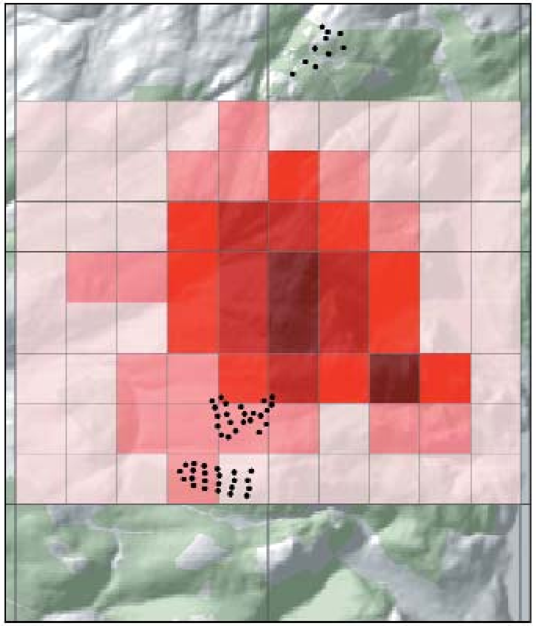
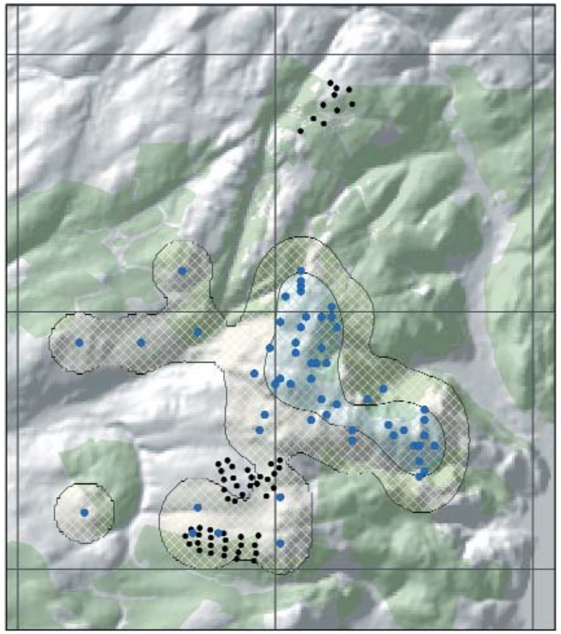
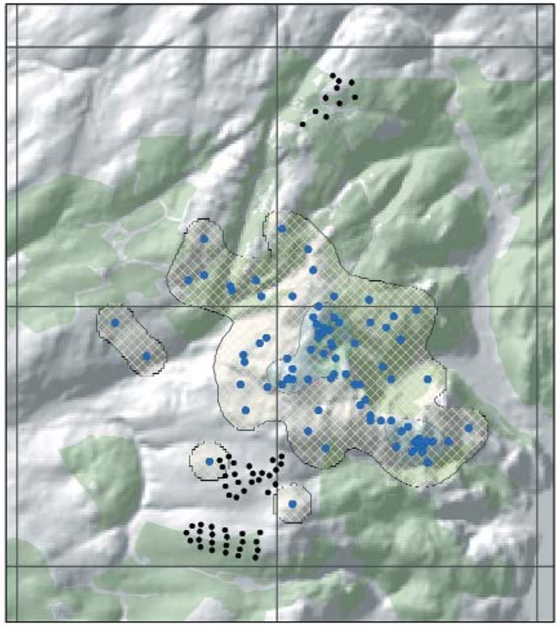


Figure 4 *Kernel analysis of ranging of resident eagles (male and female) showing their ranging before (left, n=57) and after (right, n=83) windfarm construction.*





bands of <5m, 5-20m, 21-60m & >60m) and activity (hunting, transitional flights, species interaction, display, height gain and directional flights) were noted to the nearest second, as was the time when the bird either landed or flew from view. Factors that might influence eagle behaviour (eg human activity, presence of intruding eagles) were also noted. Even when more than one eagle was visible, all flights were followed, timed and plotted. No flights were excluded from the recording process and no assumptions were made about the route or activity of birds when they were intermittently lost from view.

Analyses of eagle ranging data

Two analytical approaches were taken, one based on generating a representative set of eagle locations and one that used a grid overlaid on eagle flight lines to calculate an index of use of km^2 areas by eagles. These were used to create maps that show location, extent and concentration of use by eagles. Data on eagle ranging and habitat were entered into a Geographical Information System (GIS, ArcView 3.3 and ArcGIS, ESRI, Redlands, CA, USA), where analyses and map making were undertaken using the Animal Movement (ver 2.0) extension (Hooge and Eichenlaub 1997).

Point analysis. We framed the area in which eagles were observed by mapping the maximum extent convex polygon, the vertices of which were the most outlying of observations of eagles. The maximum extent convex polygon probably overestimates the actual range, so we also used a randomised selection of points along mapped flight lines to generate a 'representative' set of eagle locations that could be analysed. Points along plotted flight lines were selected in a way that promoted randomness and independence, while enhancing sample size. To do this we randomly selected a single point along the flight lines for each 4 hour observation bout, then selected the sequence of points before and after that random point that were separated from that point and from each other by at least 45 minutes. Observations of radiotagged, territory holding eagles in western Scotland suggested that they can fly from one end of their range to the other in < 15 minutes (McGrady unpublished data), so the 45 minute limit we set is a conservative estimate of the time needed to achieve independence between points. These randomly selected eagle locations were then used to produce maps of area use for the resident male eagle, for the resident female eagle, and for the eagles as a pair. Two representations of eagle range use were employed that used randomised point data: the minimum convex polygon (MCP) (Mohr 1947) and an adaptive kernel analysis set at 95 and 50% levels (Worton 1989). The MCP maps extent of the random location's distribution and kernel analyses map likely use of areas by eagles based on the distribution of eagle locations over time. The 50% kernel predicts the centrally located area where eagles concentrate 50% of their time, and is used by us as a nominal "core area".

One to 6 observations of intruding eagles were made per year. These are not included in our analyses, but provide useful context for interpreting behaviour of the resident eagles.

Grid analysis. The study area was overlaid with a grid that corresponded to the Ordnance Survey one km grid. We then measured the total length of flight lines recorded from our direct observations that occurred in each square. Total length of flight lines per grid square was then mapped and used as a measure of eagle use.

We made comparisons of ranging before (prior to August 2000) and after (after January 2002) windfarm construction for the male, the female and the pair using the kernel analyses and the flight line information. By way of these comparisons we assessed the effect of the Beinn an Tuirc windfarm and the effects of the associated

tree felling and habitat management. Because data are from eagles within a single range, and likely to be the same individuals, robust statistical analyses could not be undertaken.

Results

A total of 776 observation hours were logged over 194 watches. Prior to construction 98 watches were made, during construction 17 watches, and after construction 79 watches. No eagles were seen during 60 of the watches.

Golden eagle occupancy and breeding

The home range was occupied throughout the study period, apparently by the same 2 adult eagles. The eagles used a different nest in each year until 2003 when that of 1998 was reused. The eagles laid 2 eggs each year except 2003, when a single egg was laid. A single juvenile was fledged in 1997. During the study period, productivity was 0.125 young per breeding attempt.

Golden eagle ranging

The maximum extent convex polygon in which eagles ranged covered 49.2 km^2; the MCP covered 32.9 km^2 (n= 154). Thirty two percent of the Beinn an Tuirc windfarm was overlaid by maximum extent convex polygon and 28 % was overlaid by the MCP. The 95% kernel of eagle ranging covered 20.5 km^2, and had 2 core areas (50% kernel) that were both outside the Beinn an Tuirc windfarm area and covered a combined area of 2.9 km^2 (Fig 2). The windfarm area was only overlapped by the 50-95% isopleth of kernel analyses of eagle ranging ie it was not included in the core area. Table 1 summarizes the areas of 95% and 50% kernels of eagle home ranging before and after construction and the amount of overlap between eagle ranging maps and the footprint of the Beinn an Tuirc windfarm. Eagle ranging kernels are illustrated in Figures 2-4.

Three randomised locations of eagles (2.56% of all locations) were over the windfarm footprint, two (1.7%) were over turbines, and all of these were prior to construction. Additionally, 3 locations were within 500 m of the windfarm and 2 of these were prior to construction.

Kernel areas for males were similar to those of females (Table 1). Also, for both sexes kernel areas were similar before and after windfarm construction, though the shape and spatial location of the ranges shifted, mostly east and north (Figures 5 and 6) after construction.

Table 1 ***Areas (km^2) within 50% and 95% kernels for eagles during the whole study period and before and after windfarm construction. Values in () are % of eagle range that overlap the windfarm.***

	N	50% area kernel	50-95% kernel	Total 95% kernel
Male 97-04	66	3.0 (0)	17.8 (4.4)	20.8 (3.8)
Male pre construction	27	6.1 (0)	19.3 (6.7)	25.4 (5.1)
Male post construction	37	2.3 (0)	15.0 (0.03)	17.3 (0.03)
Female 97-04	88	4.9 (0)	20.8 (3.7)	25.7 (3.0)
Female pre construction	30	4.7 (0)	20.6 (8.9)	25.3 (7.2)
Female post construction	46	3.8 (0)	19.7 (2.4)	23.5 (2.0)
All birds 97-04	154	3.2 (0)	20.9 (2.7)	24.1 (2.4)
All birds pre construction	57	5.2 (0)	20.7 (9.0)	25.9 (7.2)
All birds post construction	83	6.9 (0)	33.6 (0.5)	40.5 (0.4)

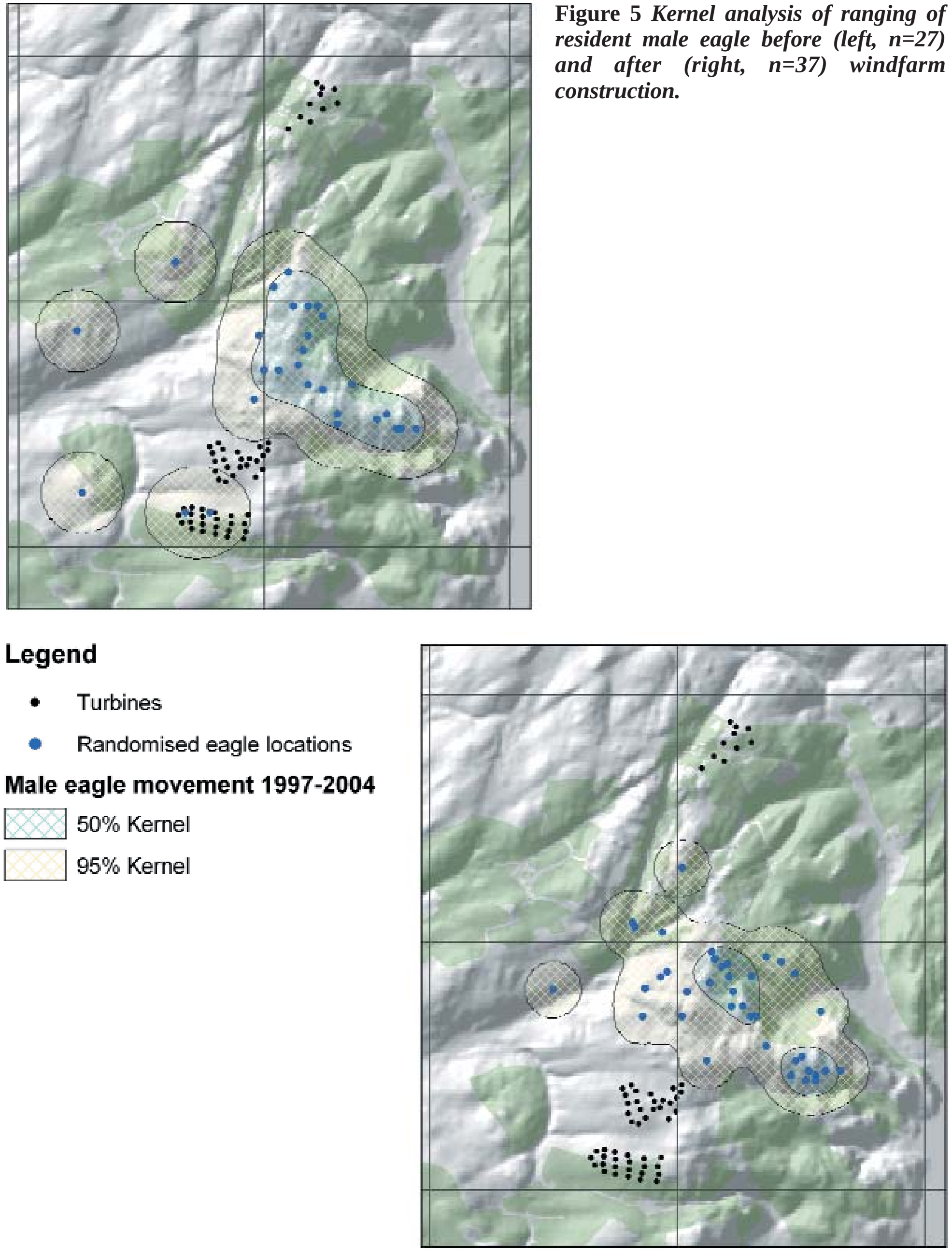


Figure 5 ***Kernel analysis of ranging of resident male eagle before (left, n=27) and after (right, n=37) windfarm construction.***

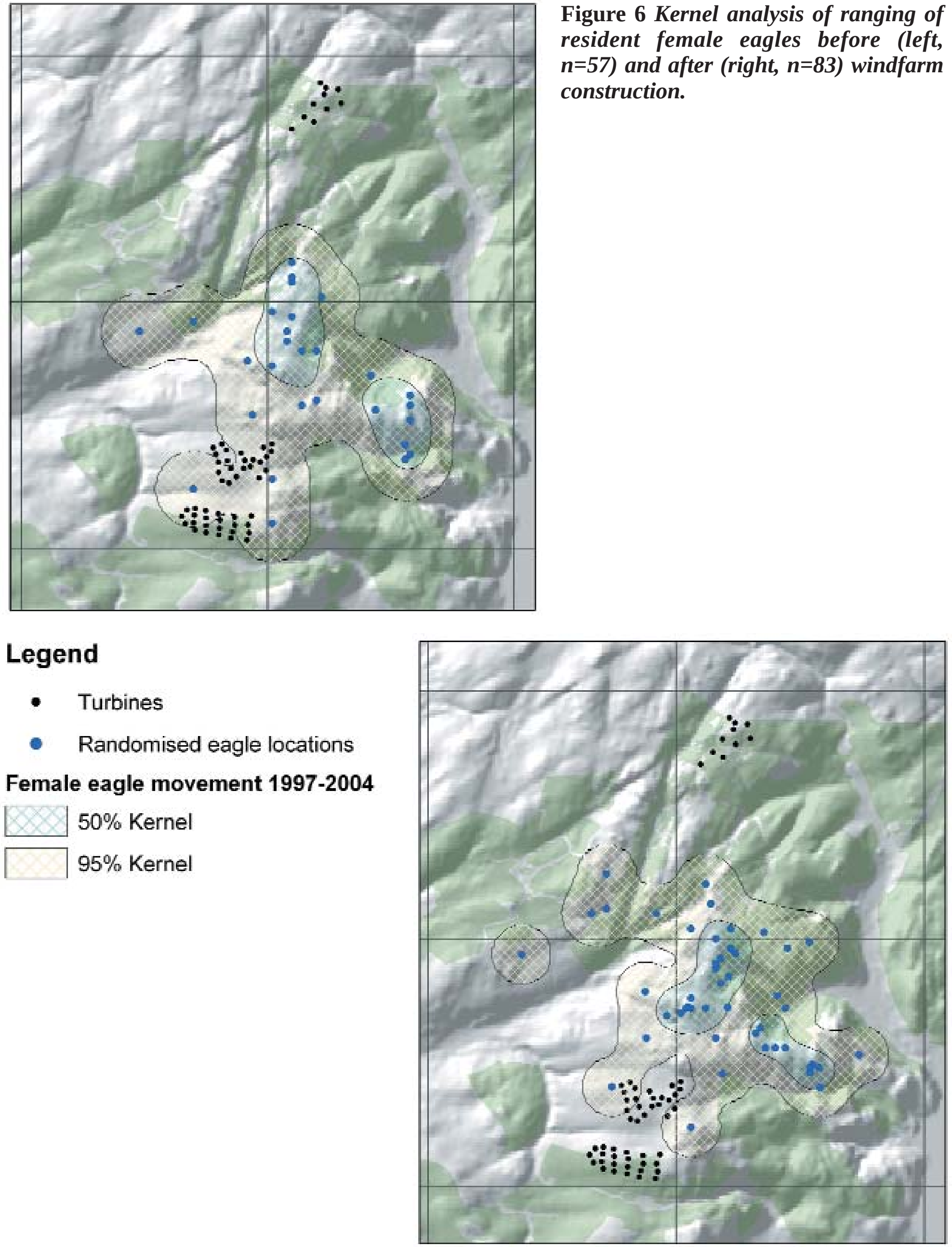


Figure 6 ***Kernel analysis of ranging of resident female eagles before (left, n=57) and after (right, n=83) windfarm construction.***

A total of 811 flight paths were mapped. Only one eagle flight line was recorded at low to medium altitude (21-60 m) within the Beinn an Tuirc windfarm after construction and this passed between the 2 discrete clusters that comprise the windfarm. In that instance the nearby presence of an intruding eagle was almost certainly a contributing factor. No eagles have been seen within the turbine clusters. Two of 3 instances of eagles over flying the windfarm were when intruding eagles were in the area.

Seventy seven percent of randomised locations were over open landcover types. The percentages of locations over different landcovers suggest the following 'preference' by the eagles: heather moor>treefell>grass hill>forest. Eighty percent of pre construction randomised locations were over open landcover types; the value was 79% for the post construction period.

Regarding the area of forestry that was felled, 21.6% of random locations prior to felling (n=37), 3.1 % of random locations during felling (n=32), and 18.8% of random locations after felling (n=85) were within this area. Eagles flew 0.095 km over the forest area prior to felling per hour of observation and 0.285 km/hr of observation after felling, a three-fold increase in use. Figure 8 utilizes flight line data and shows relative use of different areas overall and proportion of use of each habitat polygon before and after tree felling. Over 70% of total eagle flight line length was over the central open area. Figure 8 illustrates that eagles shifted their ranging to the northeast after trees were felled.

Discussion

Impacts of windfarms on birds can include collisions (See Hunt *et al* 1999 and Hunt 2002) or loss of habitat (eg Leddy *et al* 1999). In this study, resident Golden Eagles appeared to avoid the windfarm within their home range except when responding to intruders south and west of the centre of the territory. Studies exist that show that birds (eg Osborn *et al* 1998) including raptors (Curry and Kerlinger 1998) will try to avoid moving turbines.

Physical accessibility does not seem to be what hinders eagle use of the windfarm. Turbines were separated by relatively large distances, larger than tree spacing in forested areas used by Golden Eagles (Tjernberg 1983), and the eagles we studied were seen hunting Willow Ptarmigan in open patches and rides within forestry smaller than those available within the windfarm (D Walker unpublished data). In combination with the fact that resident eagles continue to forage in areas comparatively close to the windfarm especially toward the centre of the range this suggests that eagles avoid the windfarm as a unit rather than individual turbines. While food densities are comparatively low within the windfarm footprint, current potential prey populations of Willow Ptarmigan, Common Snipe and sheep carrion (S Sheridan and D Walker, unpublished data) and previous use suggest that the eagles would still forage within the windfarm area if turbines were not in place. In particular, eagle foraging might be expected here at times of relatively high grouse availability, July-October, but this has not been recorded since construction. Also, the regular presence within the windfarm of corvids, upon which eagles prey, suggests that eagles may be excluded from the windfarm. Hooded Crows *Corvus corone cornix* are a comparatively common and easily taken prey species but appear to be safe from predation while within the farm. Rotor noise and movement or prey distribution, or any combination of these factors, may be influencing eagle movement. However, we had no impression that the windfarm was avoided less during periods when the turbines were not rotating (D Walker, unpublished data).

The kernel map of eagle ranging suggests that the windfarm may act as a barrier to some areas of the range for the eagles, however VP watches prior to construction did not suggest that the windfarm footprint was along any major transit route for the eagles.

The management plan for this windfarm included activities that potentially would reduce risk of collision by reducing prey availability within the windfarm. In addition, the enhancement of other areas for eagle prey was seen as providing new feeding opportunities for eagles. According to the grid based analysis eagles did appear to more frequently use an area where trees were felled to improve foraging potential. The random point analysis did not show this, though low sample size in the pre felling period could have caused this. Willow Ptarmigan numbers have increased here (S Sheridan unpublished data) since felling, and use of the area by eagles may increase further as prey numbers recover from being limited by blanket forest and their availability increases. This may further reduce the relative attractiveness of the land within and around the windfarm to eagles.

The relative use of different habitats by the eagles to some extent reflects their foraging potential. However, even within particular habitat types there can be variations in quality and prey carrying capacity. Still, so far the findings point to the Golden Eagles at Beinn an Turic being similar to eagles elsewhere and preferring open habitats to closed ones (McGrady 1997, McGrady *et al* 1997). In contrast, eagle use has increased in areas where managed tree felling occurred. The area where trees have been felled in mitigation of open ground lost to the windfarm notwithstanding, tree growth to canopy closure in other areas will restrict use by the eagles. McGrady *et al* (1997) show that eagles avoid areas of closed canopy forestry, probably because prey becomes less available.

Our impression from direct observations of eagles and cursory examination of pellets suggest that the eagles' most important food source is sheep carrion. It also appears that carrion availability varies spatially and temporally. Carrion hot spots are located in wet flushes on the eastern sloping open ground and the windfarm area, but there was no evidence of use of carrion within the windfarm area by eagles since construction. Most sheep carcasses are removed from the windfarm area when they are found, but some are not found and these have not been used by eagles (D Walker unpublished data). Carrion availability within the windfarm area has probably declined since construction. Rabbits, Willow Ptarmigan and Hooded Crows are the main live prey species we have recorded. This prey list is similar to that recorded for eagles elsewhere in western Scotland (Watson *et al* 1993).

Increased human activity can influence eagle behaviour (including breeding and foraging behaviours) and productivity (Watson 1997), and in general, eagles tend to avoid human activity. We have no data to suggest that increased visitor pressure has caused the eagles to change their ranging behaviour. Indeed, eagles did not go into the windfarm even when no people were there. However, we were unable to monitor eagle ranging at the site during construction when human activity was greatest because of access restrictions due to Foot and Mouth Disease. The windfarm is regularly visited by turbine technicians, shepherds and eagle project and other fieldworkers. None of these activities seem likely to cause reduced eagle use because they tend to be localised and relatively infrequent. It is possible that eagles are influenced more by human activity in artificial habitats (eg windfarms or newly felled forestry) than in natural habitats, but we know of no data to support this.

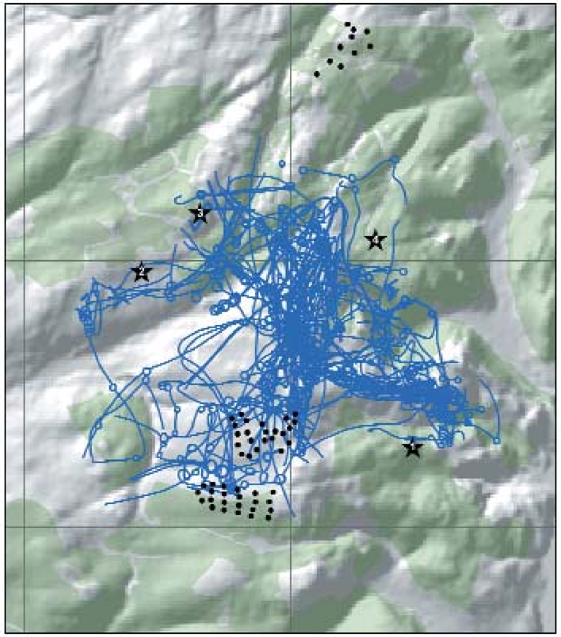


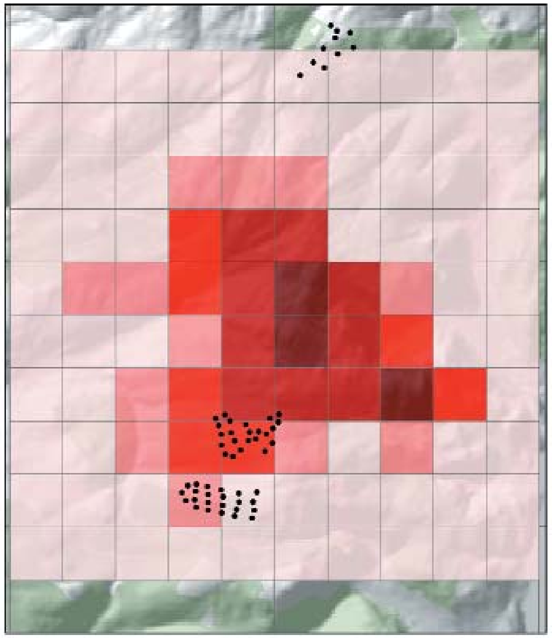
Figure 7a ***Flight paths (left), and grid of relative use of km squares (right) by Golden Eagles (male and female) before windfarm construction at Beinn an Tuirc.***

Legend

- Vantage points
- Turbines
- Flight lines
- Forestry

Metres of flight line per km square

- 0 - 5000
- 5001 - 10000
- 10001 - 20000
- 20001 - 40000
- > 40001



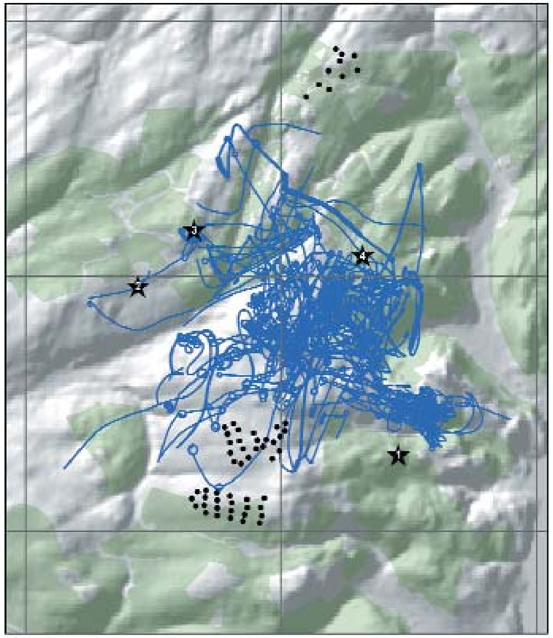


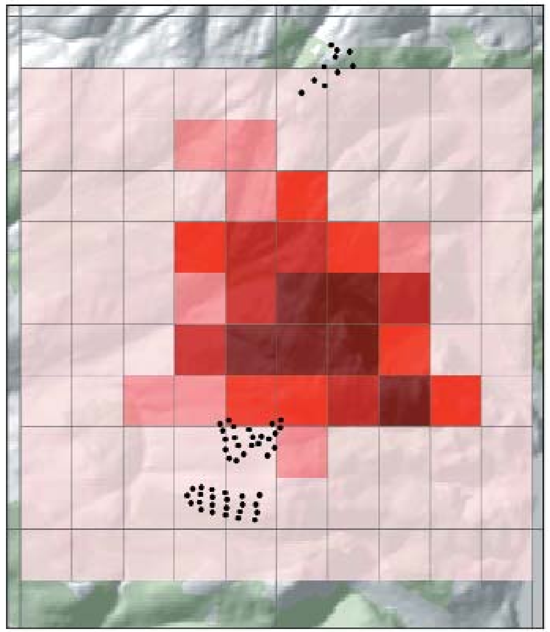
Figure 7b ***Flight paths (left), and grid of relative use of km squares (right) by Golden Eagles (male and female) after windfarm construction at Beinn an Tuirc.***

Legend

- Vantage points
- Turbines
- Flight lines
- Forestry

Metres of flight line per km square

- 0 - 5000
- 5001 - 10000
- 10001 - 20000
- 20001 - 40000
- > 40001



Intruding eagles were mostly recorded outside the breeding season over the main area of open ground and the tree felled area (D Walker unpublished data). When detected, the resident pair routinely intercepted intruding birds, even when they were towards the fringe of their range, with interactions usually consisting of the resident pursuing the intruder, sometimes with apparently aggressive approaches. In general locations away from the territory centre were associated with territorial defence behaviour, especially by the male (eg Figure 5, western edge of left map), and these added greatly to the size of the range that we mapped.

Different methods used to map animal movements have different advantages and shortcomings (Kenward 1987). We present different mapped representations of the same data to partially overcome this problem. Also, although these data are from a single pair, the number of observations (811 flight lines) is large, is spread over different seasons over 7 years, and this lessens the impact of the shortcomings of the range mapping methods.

Golden Eagle occupancy has not changed during the study period. Overall productivity of this range is 0.44 young per attempt (n=28, M Gregory, unpublished data), compared to an Argyll mean of 0.66 (1992, 96, 99-2004, Argyll Raptor Study Group, unpublished annual report 2004) and a Scottish mean of 0.52 (Watson 1997). Although productivity during the project was only 0.14 young per attempt, there is no evidence that links this low reproductive rate to windfarm construction or operation activities. Declines of this magnitude have been recorded in other ranges in Scotland where no windfarm, or indeed other change, has occurred, though we know of no published information that illustrates this. Rather, it seems that this home range has been relatively unproductive in recent years (only one chick since 1988), and this may be a result of the range viability already being challenged by the expansion of forest (Watson *et al* 1987) and the impoverishment of the flora and fauna that has occurred (Thompson *et al* 1995). We have verified the presence of the adult territorial eagles every 2 weeks, and no eagles, territorial or non territorial, are known to have been killed by colliding with the turbines. There is no indication that the resident eagles have become accustomed to the windfarm area and are more likely to use it as time passes. It remains likely that any fledglings reared at the site, intruders, or new 'naïve' replacement breeders are at greatest risk of collision.

Because tree clearance roughly coincided with the construction of the windfarm, it is difficult to say to what extent eagles responded to the clearance rather than the windfarm. However, the avoidance of the windfarm since construction suggests that the existence of relatively open areas within the windfarm is not sufficient motivation to attract eagles for foraging. Further, if the shift to the north east is a result of windfarm avoidance, then it suggests the eagles, at least at Beinn an Tuirc, 'prefer' recently felled forest areas to the windfarm.

Interestingly, though there was an overall shift to the northeast, there was no real shift in the location of the core areas. These remained in the open area that has never been under forestry to the northeast of the windfarm between blocks of forestry. This result is likely influenced by the location of the nest sites, but supports the idea that these areas are particularly important. If this relative inflexibility in location of the core area is a feature of eagles elsewhere identifying the core area and protecting it may be particularly important. Guidance by Watson *et al* (1987) and modelling of eagle ranging (McGrady *et al* 1997, McLeod *et al* 2003a, 2003b) have established nominal core areas for eagles, but these are criticised as being too simplistic, and are a point of contention between developers, conservation organizations and government agencies. More

data are needed to clarify the impact of windfarms on eagles, and it would be useful if data collected at windfarm sites elsewhere in Scotland were made available for collective analyses.

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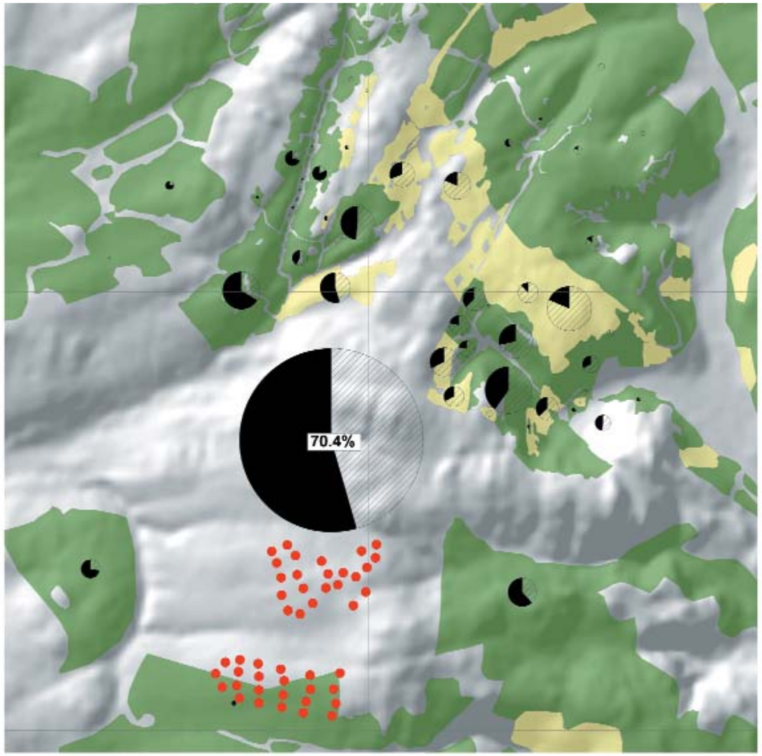
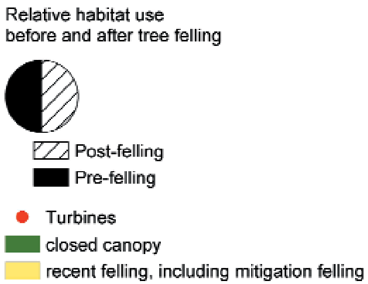


Figure 8 ***Use of habitat by Golden Eagles at Beinn an Tuirc. Size of pie chart shows relative use of habitat polygons for the whole study period, dark portion is percentage use before tree felling, and hatched portion is percentage use after tree felling.***



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