



BTO Research Report No. 375

**Ornithological survey of
a proposed wind farm
site at Hill of Nigg**

A report by the British Trust for Ornithology under contract to Shell WindEnergy Ltd.

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SUMMARY

1. Flightline surveys and transect surveys for breeding birds were undertaken at a proposed windfarm site at Hill of Nigg, Ross & Cromarty in order to assess potential collision risks on birds.
2. Flightline surveys were carried out through the year. Several species were recorded in large numbers at a potential collision height (PCH). Pink-footed and Greylag Geese occurred mainly in winter, the former in large numbers and usually at PCH. Several rare raptors were recorded at PCH (Peregrine, Red Kite, Merlin) but in very low numbers. Other more common species that were considered as potential collision risks were Buzzard, Herring Gull and Greater Black-backed Gull.
3. Transect surveys for breeding birds detected several BAP species that were likely to breed on the site. These were all relatively small species and mostly passerines which are considered at low risk of collision with turbines.
4. Two survey methods recommended by SNH and RSPB were not carried out: night flightline surveys and mapping surveys for breeding birds. The feasibility of using these methods in the future is assessed.
5. The information included within this report is insufficient to give adequate guidance on the potential impact on local bird communities of any development.

1. BACKGROUND

The British Trust for Ornithology has been approached by Shell WindEnergy to carry out preliminary bird surveys at a proposed wind farm site at Hill of Nigg, Ross & Cromarty. The site is mixed arable and pasture with some woodland, scrub, wetlands and small lochs. The site is adjacent to sea cliffs and lies close to the Cromarty Firth Special Protection Area (SPA) and Ramsar site. In order to establish whether a windfarm at Nigg Hill would or would not pose a threat to the birdlife of the area, a pilot assessment of bird use of the area was undertaken. Ornithological surveys identified the breeding bird community of the proposed site and attempted to establish whether the wind farm would be in the flight-line of any species considered vulnerable to collision. Meetings with local SNH and RSPB staff in October 2003 and subsequent correspondence, clarified that the intensity of fieldwork reported here would have been inadequate for them to declare an absence of impact of a wind farm at Hill of Nigg on their interests. In agreement with Shell Wind Energy, the following is presented as a scoping study to assess the need for any further ornithological survey and monitoring.

2. METHODOLOGY

As the proposed windfarm site lies close to the Cromarty Firth and Loch Eye Special Protection Areas (SPAs) and Ramsar site, a key issue to address is the potential impact on the qualifying species for those designations. The survey has two parts: a survey for breeding birds (April-June) and flight-line recording (all year).

2.1 Flight line surveys

Fixed point observations were made from seven vantage points (VPs) and were carried out at least every month in the winter (until March), weekly during March (to cover a critical migration period) and monthly from April until mid September. Two observers making simultaneous observations from different vantage points were used for most survey visits between October and March. Locations are shown in Fig. 1. The seven VPs were at the following grid references (where map labels are given in brackets):

NH831728 (A)
NH840723 (B)
NH828713 (C)
NH832711 (D)
NH814703 (E)
NH815700 (F)
NH821703 (G)

Observations at points A and B and E and F in the above list were for 1.5 hours each and covered dawn and dusk on each occasion – this reflects a perceived importance of these periods and area in view for the qualifying species at the nearby designated sites. The other three sites were sampled in the intervening period with observations of 1-hour duration at each. All birds seen flying through the ‘catchment’ of the VPs were systematically recorded (time, direction, number, height above ground) and key species (wildfowl, waders and raptors) had their flightlines drawn directly and accurately onto maps. Data were input using GIS to enable a comparison of flight-lines with the proposed locations of the wind turbines. Heights were recorded as categories (<10m, 10-30m, 30-50m, 50-100m, 100-200m and >200m above ground). Turbines were estimated to be 80m in height at the hub with a blade diameter of 80-100m (A. Murfin pers. comm.). For analysis purposes, any bird in the range 30-200m was considered at potential collision height (PCH).

2.2 Breeding bird surveys

Six 1-km grid squares were selected for transect surveys of birds during the breeding season (Fig. 2). Methodology followed the standard methodology used in the annual national monitoring survey, the Breeding Birds Survey or BBS (Raven et al. 2002). The goal of this sample was to estimate densities across the whole site using sample squares that were generally representative of the habitats on the site. For each square two parallel transect lines were identified, at least 200m apart, each 1km in length. These transect lines were subdivided into 200m sections. For each section, an observer would walk the transect at a steady pace and record all birds seen and heard and their approximate distance from the transect line into four distance categories: within 25m of the transect, 26-100m, over 100m and birds in flight. (Note for this latter category birds that were in flight but were considered to be using the square were recorded into distance bands rather than as in flight so as to

differentiate those individuals that were interacting with the square as opposed to those that were passing through. This category included singing Skylarks, foraging hirundines and hunting raptors). Birds were recorded where first located and care was taken to avoid double-counting. Each square was visited twice, once between 15-16th May 2004 and then again between 23rd-24th June 2004.

For each species, the maximum number of individuals per visit was determined for each distance band (or in flight) over the two visits. There were two levels of analysis carried out to provide a range of density estimates. First, site-level density was calculated using a simple formula that assumes a known detectability function where detectability is 100% in the first band (0-25m), 50% in the second band (25-100m) and 25% in the third band (100m+). Bird numbers in these bands were adjusted accordingly (i.e. doubled in the second band and quadrupled in the third band). Second, distance sampling analysis (Buckland et al. 2001) was used to estimate site-level density with the program DISTANCE. This program is only recommended in cases where there are at least 40 individuals, so this was carried out only on the most abundant species.

3. RESULTS

3.1 Flight line survey

A total of 21 visit days were carried out although on some occasions a dawn-dusk observation was carried out over two days (Table 1). At least one survey was carried out per month with the exception of February when no surveys were undertaken due to adverse weather. Three visits were carried out in March (one visit was over two days), which was one less than originally planned.

A total of 83 species were recorded. A summary of all birds recorded over these visits is given in Table 2 (note these include two categories of unidentified species types – gulls and thrushes). There were some large movements in certain species. Common species such as Rook, Herring and Common Gull, Jackdaw, Starling and Woodpigeon were always in the vicinity of the survey areas and in many cases there were many incidences of birds at PCH. There were also scarcer species, notably Pink-footed Goose that passed through the site in large numbers and in this case, most of the records were at PCH. The seasonal profile of selected wildfowl species is shown in Fig. 3. All three species (Pink-footed Goose, Greylag Goose and Mallard) show a peak in numbers towards late winter. Of other large wildfowl, there were isolated records of 4 Whooper Swan in March and 8 Brent Goose in June (both flocks at PCH). Mute Swan and Canada Goose were recorded but there was a relatively low proportion of records at PCH (Table 2). Of the raptors, Buzzards were by far the most numerous (Fig. 3) but they didn't show any strong seasonal trends. Kestrel was slightly more common at PCH in March/April. Sparrowhawk was frequently recorded on the site, but usually at low heights (Table 2). There were a number of Schedule 1 listed birds of prey recorded including Peregrine, Merlin and Red Kite (all between September and March). These species were recorded in very small numbers (1 or 2 individuals) but they were recorded at PCH. Osprey was recorded in the area but not over the proposed wind turbine locations. Hen Harrier was recorded in November and December but as is typical with this species, it was detected flying fairly close to the ground. Long-eared Owl was recorded at the site and whilst not recorded at PCH, it was strongly suspected to be breeding (near Vantage Point A). Gulls, in common with several other species, had their highest numbers in late winter (Fig. 3). Other larger species of potential conservation concern included Golden Plover (1 flock recorded at PCH), but other waders (Lapwing, Snipe, Curlew, Oystercatcher) were rarely recorded at PCH. Finally, there were a number passerines that had been designated BAP species or Schedule 1 species. In common with most of the passerines, these were rarely recorded at PCH.

Digitised maps of observed flightlines for raptors (including owls), wildfowl and waders are provided in Appendix 1. In many cases, there were very few records for species in these groups so it would be difficult to generalise about regular movements of birds in certain parts of the site. There were some species that tended to have concentrations of flightlines around particular vantage points. For example, Buzzard was recorded particularly frequently around points E and F and Mallard around points A and B. One of the more numerous species, Pink-footed Goose, was widespread and showed movements (often at PCH) across the whole of the site. Three qualifying species for the Cromarty Firth SPA were recorded on flightline surveys: Greylag Goose, Whooper Swan and Osprey. The latter species was recorded once and well away from potential turbine sites. A single group of Whooper Swans were recorded, a movement northwards of four birds at PCH. There were a number of

Greylag Goose movements (Table 2 and Fig. 3). There was some apparent tendency for movements to be in a SW or NE direction close to the coast for this species.

3.2 Breeding bird survey

The mean densities calculated by the simpler method and also mean counts of birds in flight per 1-km² are shown in Table 3. A total of 69 species were recorded on the survey. For many of these, abundance was low (21 species were density was <1 bird km⁻² and a further 27 where density was <5 birds km⁻²). The most abundant species were those that form large flocks such as Rook, Herring Gull and Woodpigeon. Many species were potentially breeding on the site (note that BBS methods do not prove breeding). Exceptions included several seabirds (Greater Black-backed Gull, Kittiwake) and sea duck (Eider, Goldeneye) which were recorded only in proximity to the coast (NH8371, NH8270 and NH8169 – see Fig. 2). There were six UK BAP species recorded: Skylark, Linnet, Song Thrush, Grey Partridge, Reed Bunting and Spotted Flycatcher. The former four species were probably breeding. Following these criteria, Reed Bunting and Spotted Flycatcher (being based on only two and one observations respectively) are not here classed as probable breeders, however habitat for both species is suitable and it is likely that with a more intensive survey method, breeding would have been confirmed.

For the more abundant species (where counts exceeded 40) densities derived from the program Distance (Buckland et al. 1994) are shown in Table 4. For most species, densities were substantially different to that presented in Table 3. This was especially the case for the smaller species, Skylark and Meadow Pipit, where detectability is likely to be low (and therefore adjustments to estimates large) in the outer distance bands. It is also noteworthy that the rank order of estimates changed between species (e.g. Rook had the highest density in Table 3 but had only the fifth highest in Table 4). Use of Distance is likely to provide better estimates of density. However, using the simpler method is still useful if relative changes are needed (e.g. from one year to the next) if we accept the assumption that errors will be constant over time.

4. DISCUSSION

Several species of conservation concern (BAP species, Schedule 1 species and SPA qualifying species) were detected during flightline and breeding surveys. Species considered potentially at risk from collisions (relatively large species recorded at PCH) included Greylag Goose, several raptors (Peregrine, Red Kite, Merlin in small numbers) and Whooper Swan (small numbers). Of the more abundant species, Pink-footed Goose (regularly moved over all parts of the site in winter with numbers peaking in March), Buzzard and gulls are also considered to be potentially at risk from collision. With the exception of Buzzard, all of these species tended to be more common outside the breeding season and raptors and geese in particular were not recorded on the breeding survey. Several smaller passerines of conservation concern were recorded in both the flightline and breeding survey, although for the former, movements were very rarely at PCH.

4.1 Methodological issues

The flightline survey attempted to determine movements of key species throughout the year and in particular whether species passing through the site were at risk of collision if turbines were erected. This entailed at least monthly visits (more in March when geese movement was likely to be highest) and covered the whole day (dawn-dusk) and for most of the year (except the breeding season when large movement are less common) two observers watched simultaneously. There is however, the possibility of substantial night movements of birds over the site.

Observations of birds from vantage points, such as those undertaken at Hill of Nigg inevitably detect only movements within daylight hours and when visibility is otherwise reasonable. Many birds, including those that are usually diurnally active, migrate at night (Zehnder & Karlsson 2001, Barlein *et al.* 2002). Similarly other local movements are also likely to occur in darkness or other conditions when visibility is poor. Studies in the Netherlands using radar (reviewed in Langston & Pullan 2003) found that birds (wildfowl and waders) flying at night tended to be at heights closer to that of turbine rotor blades than they were during the day. Although calling birds can give an indication of the numbers of birds flying through an area at night (Farnsworth *et al.* 2004), the locations of birds at night can not be reliably recorded. The use of light enhancing equipment is also restrictive in that birds can not be identified to species and the field of view is limited. Relying on calling birds and using bulky night-vision equipment is also of limited use during windy or wet conditions (including mist). An alternative is the use of mobile bird-detecting radar. Such equipment is currently rare, and as far as we are aware, the Central Science Laboratory (CSL) in York holds the only unit in the UK. The equipment is carried on a modest sized trailer and so will require drive-in access to use and can detect birds 'down to the size of a single pigeon' at a distance of 7 km. The equipment is available for rent at a cost of about £500 per day (excluding VAT) subject to its availability. As yet, BTO Scotland has not used bird-detecting radar, however we are informed that calibrations of the reflected signals can permit identification to at least bird families and that moving birds can be recorded continuously and can be plotted accurately as to flight paths and altitudes (J Bell pers. Comm.).

For breeding birds, the methodology used was the same as that used in the BBS which is the standard annual bird monitoring scheme in the UK (Raven *et al.* 2002). This method provides a relatively quick way of estimating the breeding densities within a 1-km square but cannot provide comprehensive coverage. We have used selected sample squares so some

parts of the site were not included. Also, as the survey relies on transects there will be areas further away from the transect where detectability is low. Although we can make adjustments to our density estimates for declining detectability, there still may have been some rare species that were not detected. However, transect surveys are quick, simple and highly repeatable and thus are especially good for longer-term monitoring over several years. The most comprehensive method of surveying an area is a mapping survey (Gilbert et al. 1998). This method was recommended as a breeding bird survey at Hill of Nigg by SNH. Such methods are comprehensive but extremely labour intensive, requiring a whole area search (to within 100m of all parts of the site) and several visits, but they are likely to detect all species present and are also able to more accurately determine likely breeding status. If SNH recommendations were followed and a mapping survey was carried out over the whole site, we estimate that at least 120 man-days would be required. This is unlikely to add additional information on the more common species detected (Table 3), but could potentially identify a smaller number of scarcer species breeding at the site.

In conclusion, this study has identified a number of species that are at potential collision risk at Hill of Nigg. Pink-footed and Greylag Geese are particularly at risk in late winter. Schedule 1 raptors were at potential collision risk although this must be considered low given their rarity at the site. Buzzards and larger gulls were common at the site all year and are also considered at risk. It is possible that night movements of birds and some rarer breeding species were not detected in the surveys. Further research using more comprehensive methods is possible but costs would be substantially increased. Use of the BBS methodology provides the potential to assess any effects of wind turbines on smaller birds through longer-term monitoring.

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Table 1. Dates and observation periods of flight line recording visits.

Date	Number of observers	Observation period
24/10/2003	1	Dawn-dusk
25/11/2003	2	Dawn-dusk
11/12/2003	2	Dawn-dusk
23/12/2003	2	Dawn-dusk
8/ 1/2004	2	Dawn-dusk
21/ 1/2004	2	Dawn-dusk
2/ 3/2004	2	Dawn-dusk
16/ 3/2004	2	Midday-dusk
17/ 3/2004	2	Dawn-midday
25/ 3/2004	2	Dawn-dusk
29/ 4/2004	1	Dawn-dusk
27/ 5/2004	1	Midday-Dusk
28 /5/2004	1	Dawn-Midday
26 /6/2004	1	Midday-dusk
27/ 6/2004	1	Dawn-midday
14/ 7/2004	1	Midday-dusk
16/ 7/2004	1	Dawn-midday
26/ 8/2004	1	Dawn-midday
28/ 8/2004	1	Midday-dusk
6/ 9/2004	2	Midday-dusk
7/ 9/2004	2	Dawn-midday

Table 2. Summary of flight line surveys carried out at Hill of Nigg. The data presented are for all birds recorded flying at any level and birds recorded flying only at the potential collision height (PCH). Data are in order of total recorded registrations (note that individuals are likely to have been recorded more than once and so the number of registrations given does not necessarily imply that number of individuals were present). * indicates a BAP species; + indicates a species listed on Schedule 1 of the Wildlife and Countryside Act 1981 (the highest level of protection).

Species	Total recorded	Total at PCH
Rook	9462	2726
Herring Gull	8777	5867
Pink-footed Goose	5124	4069
Jackdaw	3300	1501
Common Gull	2645	2046
Starling	1613	612
Wood Pigeon	982	195
Greylag Goose+	913	287
Carrion/Hooded Crow	815	364
Skylark*	464	127
Meadow Pipit	457	18
Rock dove	428	1
Great Black-black Gull	367	231
Chaffinch	365	240
Swallow	308	3
Fieldfare+	300	155
Linnet*	299	214
Gull spp.	277	27
Buzzard	214	107
Lapwing	170	7
Pied Wagtail	118	20
Yellowhammer	105	41
Thrush spp.	98	12
Feral Pigeon	78	16
Snow bunting+	66	16
Greenfinch	59	30
Mallard	54	27
Sand Martin	50	0
Goldfinch	49	18
Redwing+	47	9
Golden Plover	46	26
Swift	35	3
Kestrel	34	6
Blackbird	25	0
Canada Goose	25	0
Eider	23	0
House Martin	20	0
Curlew	19	1
Raven	19	10
Song Thrush*	19	0
Black-headed Gull	18	16
Blue Tit	17	4
Mistle Thrush	17	9
Mute Swan	16	2
Coal Tit	13	0
Sparrowhawk	13	1

Table 2. cont.		
Kittiwake	12	1
Magpie	11	1
Grey Heron	9	6
Lesser Black-backed Gull	9	8
Brent Goose	8	8
Teal	8	0
Cormorant	7	1
Long-tailed Tit	7	0
Twite	7	7
Oystercatcher	6	0
Snipe	6	2
Pheasant	5	0
Tree Pipit	5	0
Whitethroat	5	0
Reed Bunting*	4	1
Whooper Swan+	4	4
Wren	4	1
Siskin	3	3
Spotted Flycatcher*	3	0
Treecreeper	3	2
Tufted Duck	3	1
Brambling+	2	0
Goldcrest	2	0
Grey Partridge*	2	0
Hen Harrier+	2	0
Lesser Redpoll	2	0
Long-eared Owl	2	0
Merlin+	2	1
Peregrine+	2	1
Ringed Plover	2	2
Robin	2	0
Sedge Warbler	2	0
Barn Owl+	1	0
Collared Dove	1	0
Cuckoo	1	0
Great Skua	1	0
Osprey+	1	0
Red Kite+	1	1
Red-Breasted Merganser	1	1
Willow Warbler	1	0

Table 3. Mean (\pm SD) density of birds per km² recorded in six 1-km sample squares at Hill of Nigg in decreasing order. Densities were calculated assuming a 50% reduction in detectability at 25m and a further 50% reduction at 50m from the transect line. Average count per square of birds recorded in flight are also given. * indicates Scottish BAP species.

Species	Density	SD	Flying birds	SD
Rook	122.33	64.65	9.66	9.07
Herring Gull	40.50	54.09	55.16	25.26
Woodpigeon	23.16	17.41	14	7.48
Meadow Pipit	18.66	9.66	2.66	4.84
Swallow	15.66	8.12	8.33	11.20
Jackdaw	14.5	18.63	1	2.44
Skylark*	12.5	3.61	2.66	4.22
Blackbird	11.83	5.77	0	0
Wren	11.66	9.11	0.33	0.81
Mallard	11.33	7.76	1	1.54
Carrion Crow	10.83	7.65	15.5	3.14
Eider	10	24.49	0	0
Pheasant	9.66	8.50	0.33	0.81
Pied Wagtail	9.66	4.27	0.33	0.81
Yellowhammer	8.5	7.39	0	0
Sand Martin	6.16	4.99	10.66	15.06
Black-headed Gull	6	9.38	0.33	0.81
Linnet*	5.5	3.56	0.33	0.81
Cuckoo	5.33	8.	0.16	0.40
Hooded Crow	5.16	3.43	3.83	2.71
Chaffinch	5	6.38	0.33	0.81
Greater Black-backed Gull	4.66	3.72	15.66	13.60
House Sparrow	4.66	11.43	0	0
Mute Swan	4.66	8.16	0.66	1.63
Buzzard	4.16	8.40	3	2.28
Song Thrush*	4.16	5.60	0	0
Starling	3.83	5.94	0	0
Great Tit	3.5	2.16	0	0
Willow Warbler	3.16	4.11	0	0
Oystercatcher	3	3.03	0.66	1.63
Whitethroat	2.83	2.85	0	0
Grey Partridge*	2.66	4.84	0.16	0.40
Tufted Duck	2.66	3.26	0	0
Blue Tit	2.5	2.16	0	0
Sedge Warbler	2.5	2.88	0	0
Common Gull	2.33	5.71	0	0
Twite	2.33	2.65	0	0
Robin	2.16	2.14	1.33	3.26
Wheatear	2	2.09	0	0
Goldcrest	1.83	2.40	0	0
Treecreeper	1.83	3.12	0	0
Coot	1.66	2.65	0	0
Mistle Thrush	1.66	2.25	0	0
Kestrel	1.5	1.97	0.33	0.51
Crossbill	1.33	1.63	0	0
Curlew	1.33	2.06	0	0
Siskin	1.16	1.83	0	0
Long-tailed Tit	1	2.44	0	0
Greenfinch	0.83	1.32	0	0
Table 3. cont.				

Tree Pipit	0.83	2.04	0	0
Rock Dove	0.66	1.633	0.5	0.83
Goldeneye	0.66	1.633	0	0
Lesser Redpoll	0.66	1.633	0	0
Raven	0.66	1.633	1.33	1.63
Reed Bunting*	0.50	1.22	0	0
Blackcap	0.33	0.81	0	0
Garden Warbler	0.33	0.51	0	0
Stonechat	0.33	0.81	0	0
Snipe	0.33	0.81	0.16	0.40
Tawny Owl	0.33	0.81	0	0
Kittiwake	0.16	0.40	1.16	2.04
Spotted Flycatcher*	0.16	0.40	0	0
Sparrowhawk	0.16	0.40	0.33	0.51
Goldfinch	0	0	0.33	0.81
Great Spotted Woodpecker	0	0	0.33	0.81
Heron	0	0	0.33	0.51
Lapwing	0	0	0.66	1.63
Pintail	0	0	0.16	0.40
Swift	0	0	0.33	0.81

Table 4. Density estimates per km² and 95% confidence intervals of the 7 commonest species occurring in six 1-km sample squares at Hill of Nigg. Estimates were derived from Distance sampling software (Buckland et al. 1994).

Species	Density	LCL	UCL
Herring Gull	20.83	8.36	51.87
Woodpigeon	21.86	10.54	45.32
Meadow Pipit	102.62	76.63	137.43
Skylark	173.85	127.30	237.43
Swallow	50.01	29.14	85.84
Rook	34.17	13.43	86.94
Jackdaw	90.35	35.77	228.24

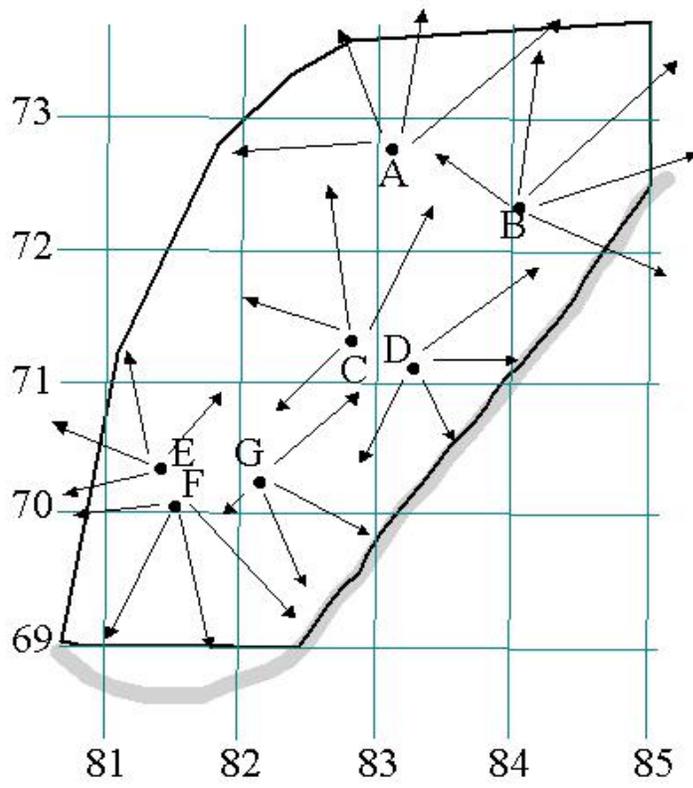


Fig. 1. Locations of the seven vantage points used in the flight line surveys at Hill of Nigg. 1-km grid squares are also given.

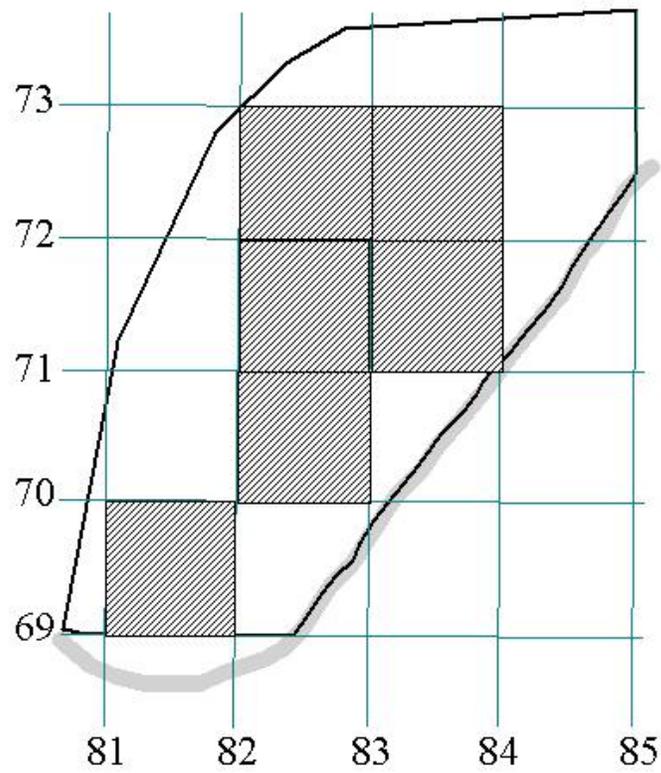


Fig. 2. Locations of the six 1-km squares used for transect surveys following BBS methods at Hill of Nigg.

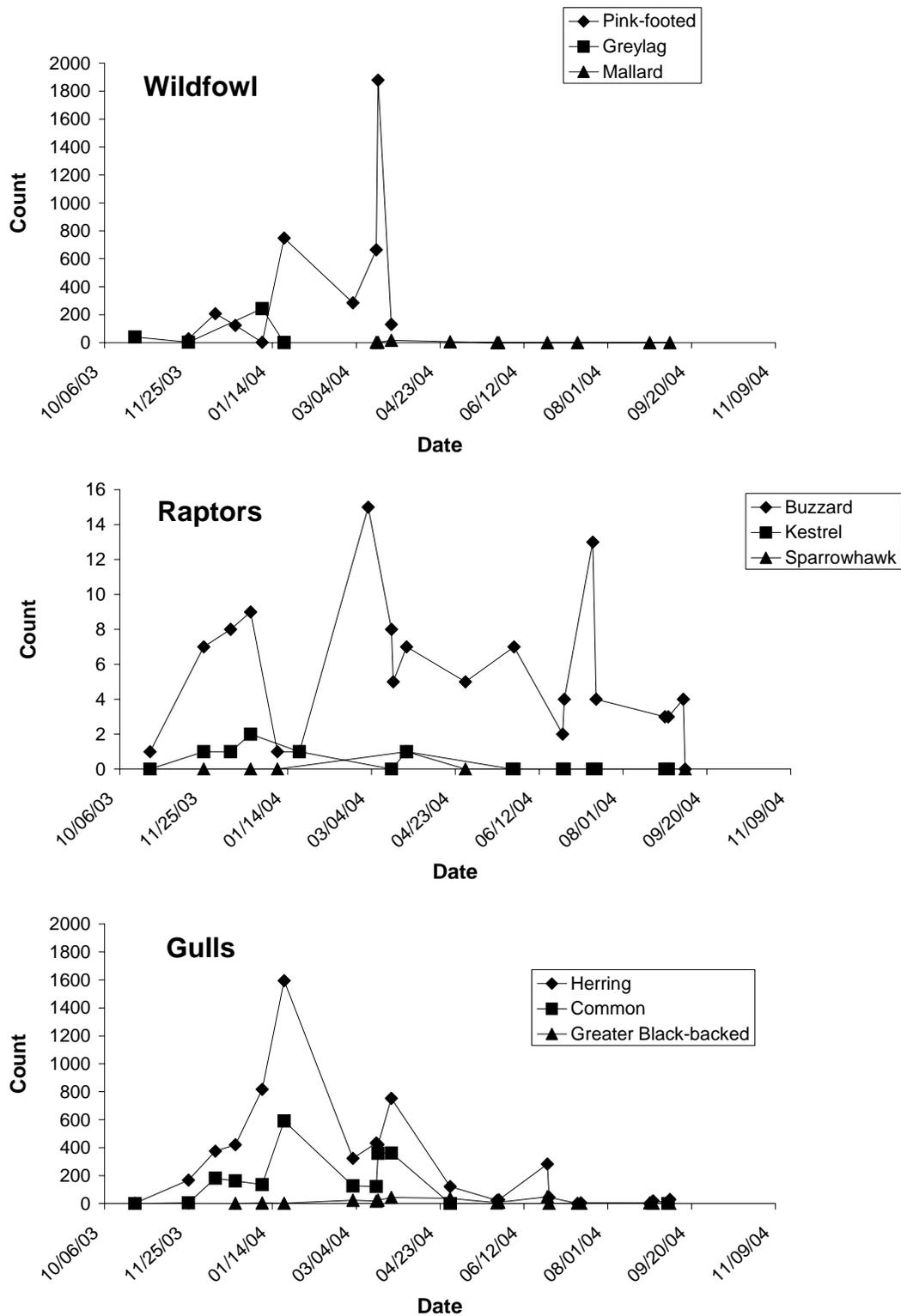
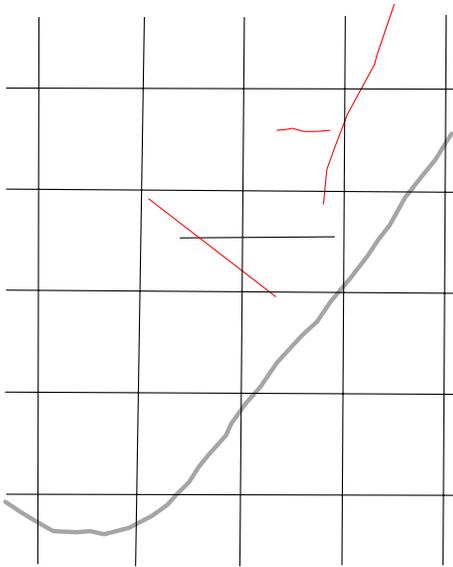


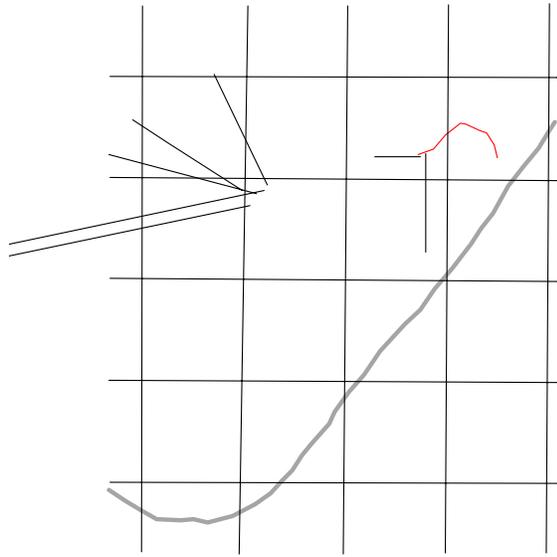
Fig. 3. Seasonal counts of selected species detected at PCH during the flightline surveys. Note dates are shown as mm/dd/yy. Dates for all surveys are given in Table 1.

Appendix 1. Flightline maps of all raptors, waders and wildfowl recorded. Each line can represent either individual birds or flocks. Red lines represent flightlines at PCH (30-200m), black lines represent flightlines at other heights.

Grey Heron



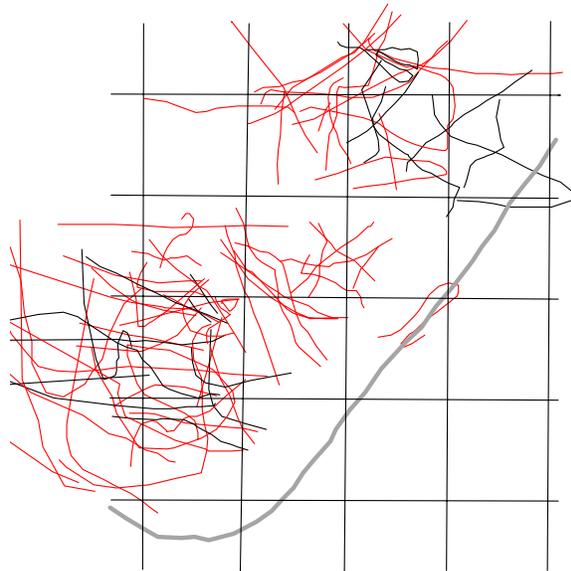
Mute Swan



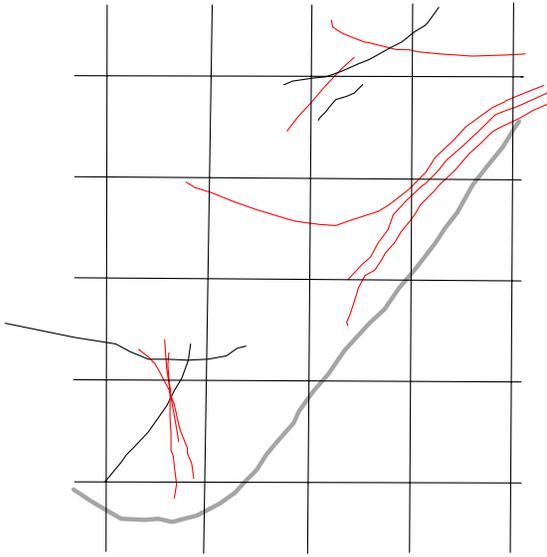
Whooper Swan



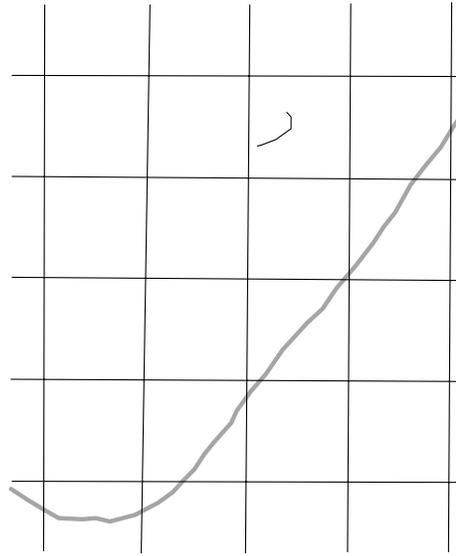
Pink-footed Goose



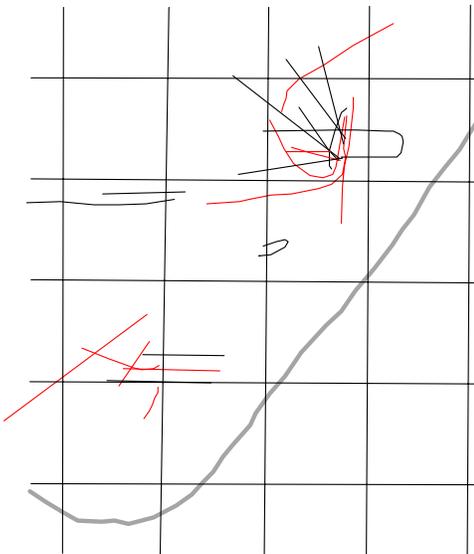
Greylag Goose



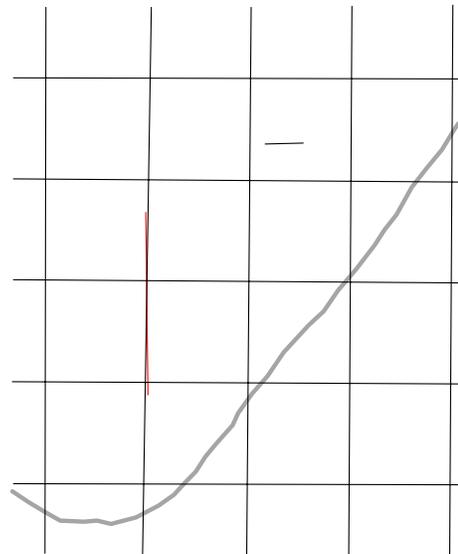
Teal



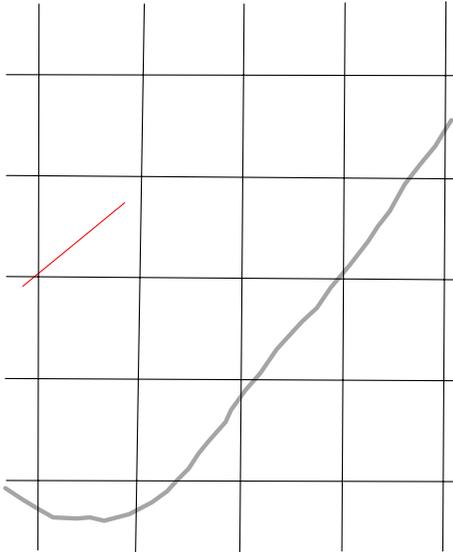
Mallard



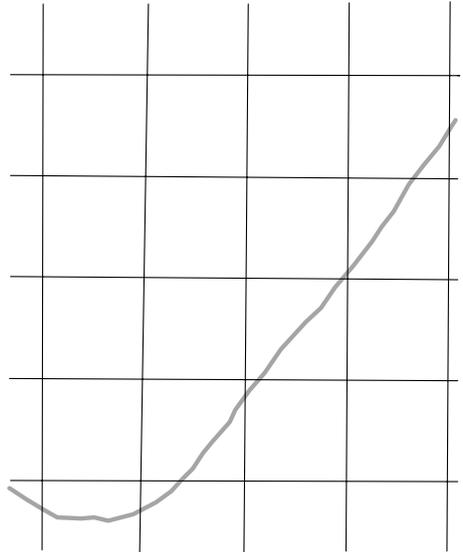
Tufted Duck



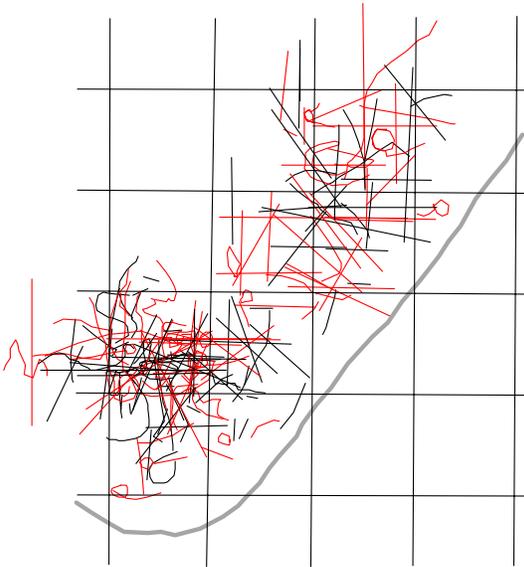
Red-breasted Merganser



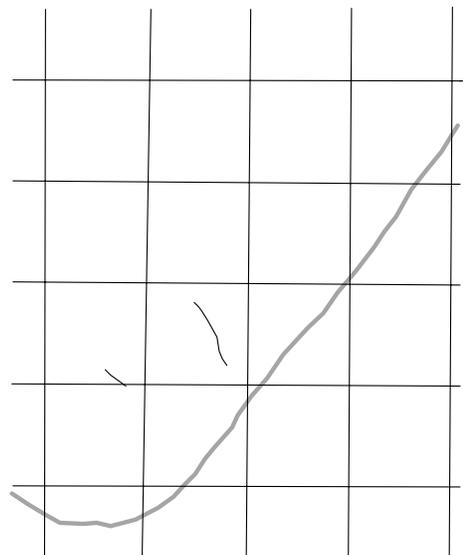
Osprey



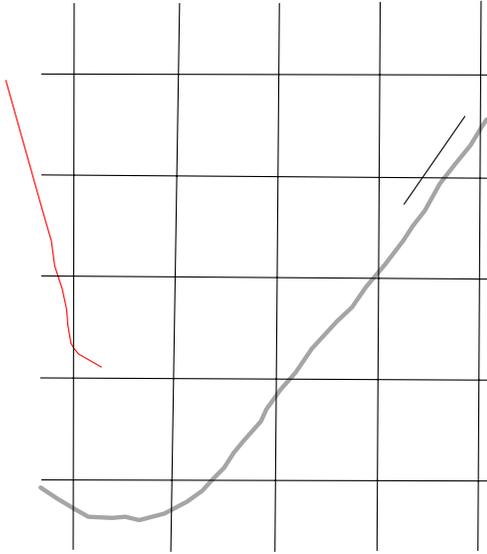
Buzzard



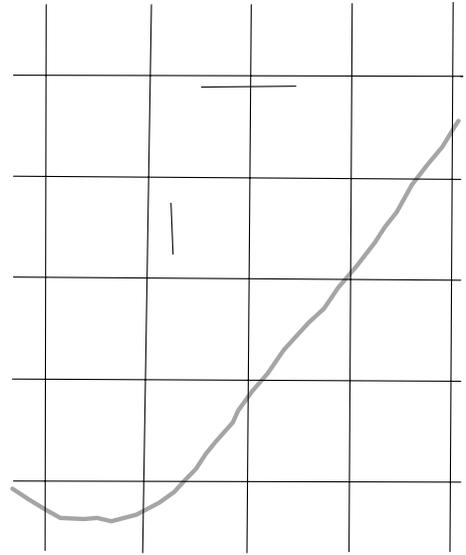
Hen Harrier



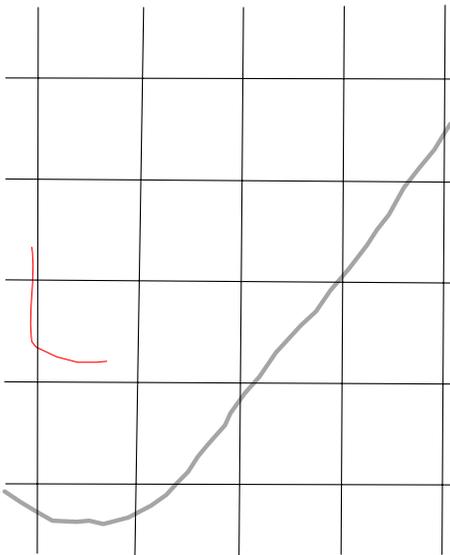
Peregrine



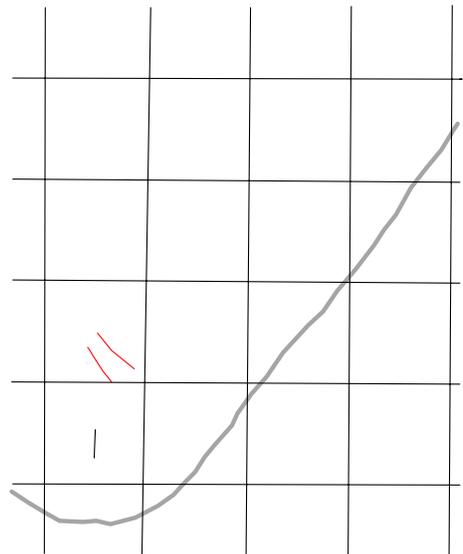
Oystercatcher



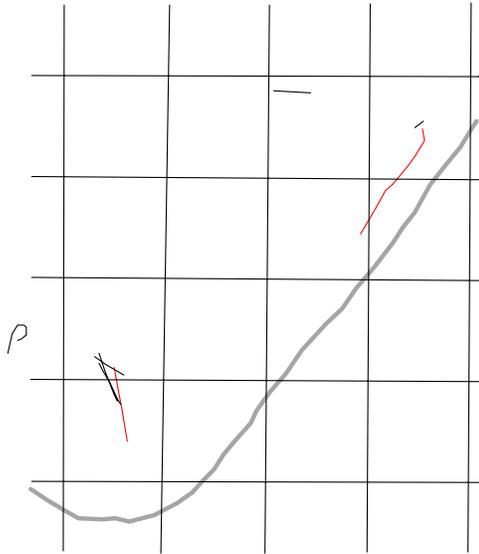
Ringed Plover



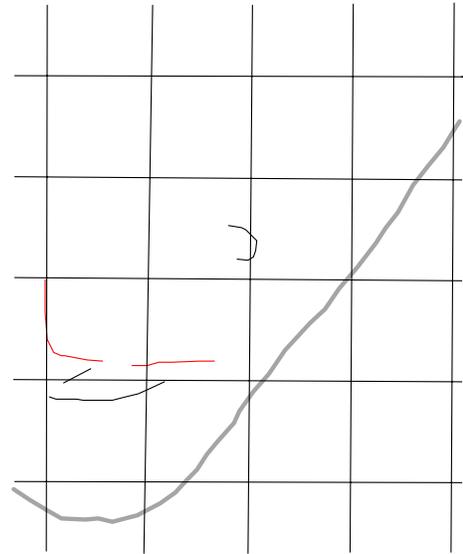
Golden Plover



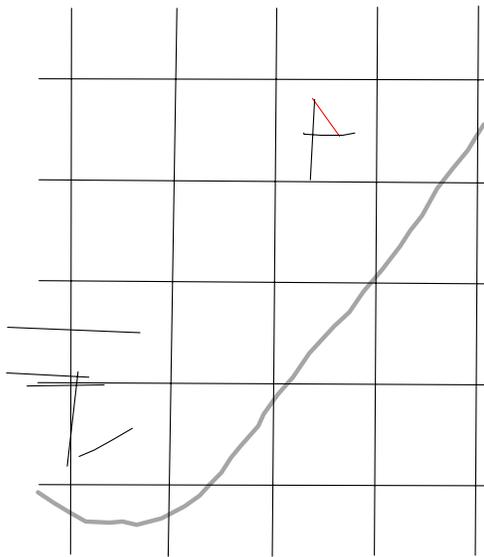
Lapwing



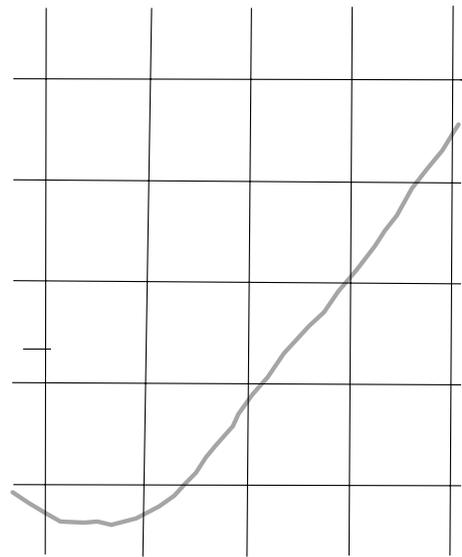
Snipe



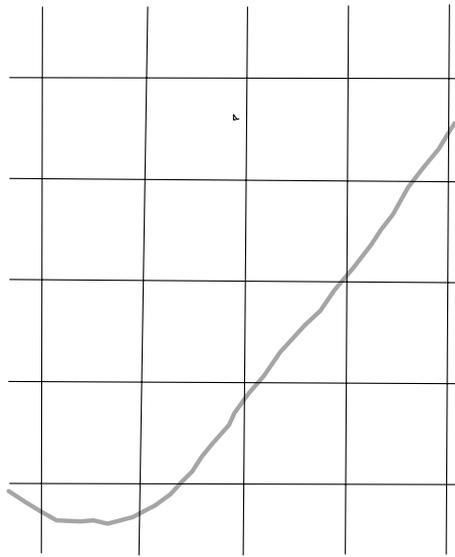
Curlew



Barn Owl



Long-eared Owl



Raven

