South Moor Farm,

Langdale End, Scarborough

Bird Assessment

November 2016

QUANTS environmental Ltd

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Contents

1 Introduction and Background

1.1 Introduction

This report presents the results of a bird assessment undertaken at South Moor Farm, Langdale End, Scarborough, YO13 0LW in relation to a proposed single grass runway and small control room. The site is centred at approximate grid reference SE907902 (see Figures 1 and 2) approximately 10 km north-east of Pickering town centre and approximately 13 km west of Scarborough town centre. The proposed runway is approximately 600 metres in length; it lies at approximately 240 metres above sea level at the south-western end and slopes down to approximately 210 metres above sea level at the north-eastern end.

The aims of this assessment were to determine the potential for nightjar *Caprimulgus europaeus* and goshawk *Accipiter gentilis* to be affected by the proposed development.

An ecological field survey was undertaken on 25th October 2016 and a desk-based study was undertaken in October 2016 to obtain previous bird records for the site and the surrounding area.

A grass runway is currently in situ at the site (see photos at Appendix 1). Under the site's current agricultural land use, the runway can be used on up to 28 days per year. The forthcoming planning application relates to a proposed change of use to enable the runway to be used on an unlimited number of days. It is understood that all flights from the runway would be during daylight hours only.

It is noted that the previous planning application and subsequent appeal described below related to 2 no. grass runways and construction of pilot/restroom building; whereas the proposal is now for a single runway and a small control building measuring approximately 2 x 3 metres.

1.2 Background

A planning application, dated 2 November 2015 (Ref NYM/2015/0781/FL) for '*change of use of land to form 2 no. grass runways and construction of pilot/restroom building*' at South Moor Farm, Langdale End, Scarborough, YO13 0LW, was refused by North York Moors National Park Authority (NYMNPA) on 15th January 2016.

Subsequently, an appeal (Ref: APP/W9500/W/16/3144478) was made by the applicant against the refusal to grant planning permission. The appeal was dismissed by the Planning Inspector (decision date: 16th September 2016).

Regarding 'the effect of the proposal on wildlife', the Appeal Decision stated the following:

> *23. The North York Moors Special Protection Area (SPA) lies around 6km to the north-west of the site. The Troutsdale and Rosekirk Dale Fens Site of Special Scientific interest (SSSI) lies around 2.5km to the south and the Bride Stones SSSI is a similar distance to the west. Advice from the Royal Society for the Protection of Birds (RSPB) indicates that the site also lies close to areas of forest identified as a breeding site for Nightjar and Goshawk, the latter of which is a species protected under Schedule 1 of the Wildlife and Countryside Act. Natural England have advised that if representations are received during the planning process which indicate that protected or priority species may be present on the site, further survey work should be carried out to determine their presence prior to determination.*

> *24. In the first previous appeal the Inspector noted that he had limited information on which to determine the risk to protected species. Nevertheless, based on the case put to him, he considered that other than in the immediate surroundings of the proposed airstrip, the noise from take-offs and landings would be unlikely to cause any significant disturbance. This together with the small number of movements, suggested to him that there would be unlikely to be any disturbance to Goshawks or Nightjars. In the second appeal the ecology of the site does not appear to have been a matter that was put before the Inspector.*

> *25. At the hearing I was provided with evidence from a Mr Gary Marchant, a consultant ecologist and local ornithologist who stated that a number of species were present in the*

area around the site, including Goshawks, a species which I was advised are very sensitive to noise. Although I was provided with no firm evidence that these species nest close to the appeal site, I take into account that as a protected species Goshawk breeding sites are kept confidential. I also take into account that he has extensive professional experience which includes work in and around Dalby Forest. This evidence, along with the written comments of the National Park Ecologist leads me to the view that there is a reasonable prospect of both species being present.

26. The application is not accompanied by a wildlife survey, but rather a desk-top assessment which indicates that given the distance to designated sites and the species within them, the proposal is unlikely to be a habitat for SPA species. I do not consider that the pattern of use proposed would result in intensive use of the site, and note that aircraft noise can be compatible with birdlife in the case of a number of other airfields which have been drawn to my attention. Based on the information before me I am nonetheless conscious that there is a reasonable prospect of protected species being present and that the development proposed has the potential to adversely affect them. However, in the absence of any detailed habitat survey for the presence and likely effect on protected species in and around the site, I cannot be sure of the extent of likely harm, if any.

27. As this is the only matter in which I have identified potential harm, I have carefully considered whether a condition requiring that a survey be undertaken could mitigate any potential impact. However, Circular 06/052 advises in paragraph 99 that it is essential that the presence or otherwise of protected species, and the extent that they may be affected by the proposed development, is established before the planning permission is granted. The need to ensure ecological surveys are carried out should therefore only be left to coverage under planning conditions in exceptional circumstances. Based on the information before me I am not aware of any circumstances which would negate the need to address this issue as a material consideration.

28. I bear in mind that previous appeal decisions are material considerations to which I must have regard. However, as I have evidence before me which does not appear to have been put to the original Inspector, I am satisfied that there is no inconsistency in our decisions. I also take into account that the conservation of wildlife is explicit in the statutory purposes of the National Park, and is reflected in Core Policy C of the Core Strategy. According I must conclude that the failure to demonstrate that protected species would not be harmed runs contrary to local and national policy and must be given significant weight.

Figure 1. Site location outlined in yellow (aerial image dated 2009)

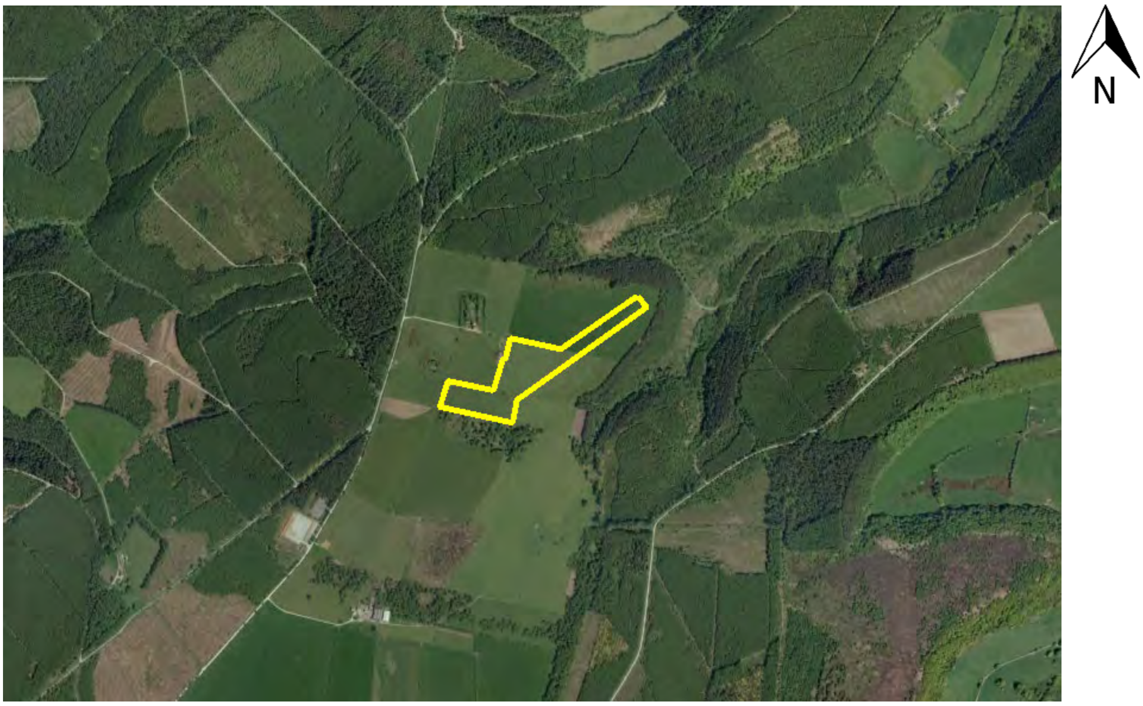
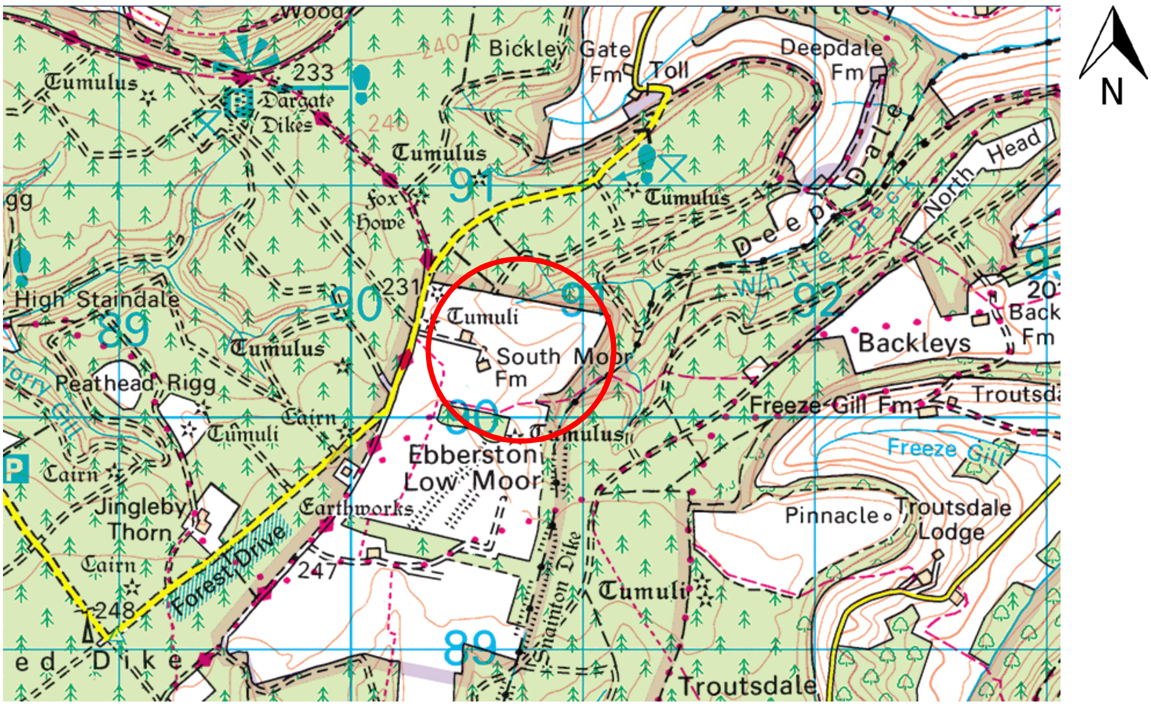


Figure 2. Site location circled in red



2 Assessment Methodology

2.1 Desk Study and Literature Review

North and East Yorkshire Ecological Data Centre (NEYEDC) was contacted for a search of bird records within a 1 km radius of the sub-500 foot flight path shown in Appendix 3, i.e. a straight line between grid reference SE893891 in the south-west and SE917910 in the north-east.

Several attempts were made to contact the Forestry Commission (Pickering office) to obtain information regarding nightjar and goshawk in Langdale Forest and the wider area. At the time of writing, no information had been received.

A search for protected nature conservation sites was undertaken on the Multi Agency Geographic Information for the Countryside (MAGIC) website[1].

A literature review was also undertaken. The aim of the literature review was to search for background information regarding the effects of light aircraft on nightjar and goshawk. The literature review was extended to include information regarding the effects of other relevant disturbance effects, e.g. from other types of aircraft and other anthropogenic sources.

2.2 Field Survey

An ecological field survey was undertaken on 25th October 2016. During the survey, all land within a 1 km radius of the sub-500 foot flight path shown in Appendix 3 was assessed in terms of its potential value to nightjar and goshawk as habitat for breeding, feeding or other behaviour. During the field survey, any observations of notable bird species were recorded (no evidence of nightjar or goshawk was observed during the survey).

The survey involved walking along the majority of paths, tracks and roads within the survey area. There is an extensive network of paths in the survey area used by mountain bikers and walkers. Additionally the surveyor walked along Dalby Forest Drive which is used by visiting traffic and forest vehicles. During the field survey, all areas of relevance were fully accessed. The majority of the land within a 1 km radius of the sub-500 foot flight path shown in Appendix 3 is designated as ‘open access land’ under The Countryside and Rights of Way Act 2000. Non-‘open access land’ within the survey area was largely visible from public rights of way.

2.3 Personnel

All survey and assessment work has been undertaken by Toby Fisher CEnv MCIEEM.

2.4 Limitations

The field survey was undertaken in October 2016 which is outside the main bird breeding season. During October it is not possible to confirm the presence or absence of nightjar or goshawk as breeding species. Nightjar winters in Africa and is typically present in breeding territories in the UK only between May and August. Goshawk is resident in the UK but the population is normally bolstered during the winter by birds which breed in continental Europe but winter in the UK; goshawk territorial behaviour typically occurs between February and August.

During the field survey on 25th October 2016, all areas of relevance were fully surveyed and there were no significant access limitations.

Regarding the NEYEDC data search, it is noted that many species records are not supplied to records centres due to various reasons including the threat of illegal egg-collecting particularly for the rarer raptors such as goshawk.

[1] http://magic.defra.gov.uk/

3 Background Ecology and Other Information

3.1 General Notes on Avian Responses to Aircraft

Most species of bird have evolved predator-evasion responses as a technique to avoid aerial predators such as raptors[2]. This predator-evasion response will sometimes be elicited erroneously, such that birds respond to the sudden approach of animals or machines that are essentially harmless.

Ruddock and Whitfield[3] defined two types of disturbance response. 'Static' disturbance distance was defined as the distance at which there was a static behavioural response to the disturbance stimulus, such as increased vigilance and/or alarm calling. 'Active' disturbance distance was defined as the distance at which there was an active behavioural response to the disturbance stimulus, for instance taking flight, moving away from/towards the observer.

Not all bird species will exhibit the same predator-evasion response to a given stimulus. There is significant inter-species variation with some species flying off when the stimulus is several hundred metres away and some species using crypsis[4] and only flying off when the stimulus approaches to within a few metres. There will also be significant intra-species variation, whereby individuals of the same species will react to the same stimulus at different distances; this may be because individuals in a certain location (e.g. near a long-established airfield) have become attenuated to non-predator stimuli such as aircraft.

The predator-evasion response will also be affected by the nature of the habitat, e.g. birds may feel safer from aerial stimuli when they are within, or close to, a cluttered environment such as a woodland and may therefore be less likely to exhibit a predator-evasion response. This effect may be more marked if the stimulus is large (e.g. an aircraft) and therefore perceived as less able to effectively pursue prey within a cluttered woodland canopy environment. Species which spend much of their time on open-ground with no nearby woodland cover tend to be most susceptible to disturbance from aerial stimuli, e.g. wintering flocks of geese are known to exhibit predator-evasion responses at distances of over 1 km from aircraft.

Repeated predator-evasion responses can adversely affect birds by increasing their energy-expenditure (i.e. energy reserves are used up every time a bird makes a flight); reducing the time available to participate in other activities such as feeding, defending a territory and rearing young; and causing birds to be displaced from otherwise favourable habitat.

Scottish Natural Heritage[5] states that raptors may react to aerial disturbance in a number of ways. They have been recorded watching nearby aircraft, 'flattening' or 'clamping down' on nests (usually in incubating or brooding birds) and standing up on nests with eggs or chicks. Birds may also be flushed from the nest, and may delay returning to the nest or a change-over between the pair during incubation or brooding being disrupted. This can result in the nest being unattended for an extended period, and the eggs or young chicks being vulnerable to the effects of weather (chilling or overheating), starvation or predation. Breeding birds may also be panicked off a nest and, in the process, dislodge eggs or young leading to a breeding failure[5].

Behaviour of young in nests is not well studied but there is evidence to suggest that they can 'flatten' on the nest or exhibit startled/panic behaviours. This latter reaction can lead to

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2 Raptors = birds of prey, e.g. eagles, falcons and hawks.

3 Ruddock M and Whitfield DP. (2007). A Review of Disturbance Distances in Selected Bird Species. A report from Natural Research (Projects) Ltd to Scottish Natural Heritage. 2007.

4 Crypsis is the ability of an animal to avoid observation or detection by other animals, e.g. by camouflage and/or remaining motionless.

5 Scottish Natural Heritage. (2015). Guidance. The use of helicopters and aircraft in relation to disturbance risks to Schedule 1 & 1A raptors and wider Schedule 1 species June 2015.

premature fledging in older chicks which risks injury and potential abandonment by the parents, although the latter is probably rare[5].

Less commonly, territorial adults can show defensive or aggressive reactions to aircraft by treating them as an intruder. This can manifest as circling or mobbing (birds have sometimes been heard using alarm calls) or 'shadowing' (following the aircraft's movements by flying alongside or above) the aircraft. In more extreme cases birds may attack the aircraft[6]. This most often leads to the injury/death of the bird, but aircraft have also been damaged or brought down in such incidents. Video evidence from cameras on drones in the USA has shown raptors will attack the drone as an intruder if it used irresponsibly close to a nest[5].

In some cases, disturbance by helicopters has led to raptors shifting nest site the following year even if they have bred successfully despite disturbance[5 7].

There is evidence that birds may habituate over time to aircraft activity[8], but where it remains irregular or sporadic, or where background levels increase over time, there is a greater risk of disturbance[9]. There is, however, individual variation between birds, and some will tolerate more disturbance than others[5].

Although based on only six observations, Evans[10] concluded that wintering pink-footed geese rapidly habituated to the presence of microlights landing and taking off from an airstrip only 250m from their feeding grounds.

Smit and Visser[11] observed that waders exhibited a high degree of habituation to the 'predictable' stimulus of helicopters passing regularly overhead at a frequency of 2-3 hour at 100-300m altitude. However, 'unusual' types of plane, which showed up at low frequencies still had strong effects.

Aircraft may disturb birds both visually and audibly. Drewitt[9] concluded that helicopters disturb more than fixed wing aircraft although there are a number of factors that can affect the level of disturbance. These include the timing and frequency of flights; type of aircraft (e.g. different helicopters have different noise signatures); existing level of aircraft flight activity; height and speed of flight; type of flight (e.g. single pass or repeat passes) and distance from nests and roosting areas[5].

Flights less than 500m in altitude are considered to present a higher risk of disturbance to birds[9]. Many flying operations typically involve flights between 100-300m in altitude, e.g. material transfer and surveys. Low flying military jets are often considered to be less of an issue due to the speed at which they pass. There is some evidence from the USA that raptors can habituate on military training grounds and also evidence that their reaction to the sonic boom of a passing jet is similar to that of a natural thunder clap (i.e. very little reaction). In contrast there are also cases of birds flushing from nests, chicks showing a startle reaction, and individual birds panicking in response to military jets, although these have usually involved a relatively close approach[5].

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[6] Gregory, M. (1985) Glider attacked by golden eagle. Scottish Birds, 13, 230-231.

[7] Platt, J. B. (1977). A study of wintering and nesting Gyrfalcons on the Yukon North Slope during 1975 with emphasis on their behaviour during experimental overflights by helicopters. Ch. I. in Ornithological studies conducted in the area of the proposed gas pipeline route: Northern Alberta, North Western Territories; Yukon Territory and Alaska 1975 Arctic Gas Biol. Rept. Ser. Vol 35.

[8] Grubb, T. Y, Delaney, D. K., Bowerman, W. W. & Weirda, M. R. (2010) Golden eagle indifference to heli-skiing and military helicopters in northern Utah. Journal of Wildlife Management, 74, 1275-1285.

[9] Drewitt. A. (1999) Disturbance effects of aircraft on birds. English Nature Birds Network Information Note.

[10] Evans ME. (1994). Microlights and geese: s study of the effects of microlights operating at Tarn Farm, Cockerham, upon wintering pink-footed geese. English Nature and the Ribble Valley Microlight Club.

[11] Smit and Visser (1993) cited in Drewitt (1999).

Experimental studies of the effects of microlights on pink-footed geese[10] indicated that they caused no detectable disturbance of geese, lapwing or golden plover when at an altitude of over 1000ft; signs of disturbance were first noted at 500ft.

Most recorded incidents of flushing from nests have occurred due to a combination of the aircraft being relatively close to the nest (most within 300m), sudden appearance over a ridge or cliff, lingering near corries or ridges and/or repeated passes. Noise effects in more enclosed glens or corries and visual disturbance may also contribute to disturbance, but there is limited direct evidence for this. Noise transmission may be influenced by the local topography or wind speed/direction, so it should not be assumed that birds will already be alert to the presence of the craft in the area[5].

Other raptor disturbance behaviours related to aircraft have been recorded in literature at distances out to 800-850m[5] [12].

Aerial surveys for raptors in North America use methods to minimise the risk of disturbing birds. These include a slow and obvious approach from as far out as possible and minimising the time spent close to a nest. This greatly reduces flushing or defence/aggressive responses, although does not eliminate them altogether[5].

There is some evidence for raptor nests failing due to aircraft disturbance but few confirmed records because of the relatively low intensity of nest monitoring and inability to rule out other factors. It has, however, been suspected as being a more regular causal factor in breeding failures than the confirmed incidents suggest. Obvious disturbance of flushed birds is much more often reported, although many of these birds have gone on to breed successfully[5].

Bird strike is also a risk in lower level flying. These may result from defensive/aggressive reactions and are probably not widely considered by the operators/pilots in their risk assessments. More typical bird strikes for raptors have also been recorded[5].

SNH guidance[5] provides ‘Safe Working Distances’ (both lateral and altitudinal) for 6 raptor species (not including goshawk) with recommended lateral distances ranging from 300m for red kite to 1000m for golden eagle and recommended altitudinal distances ranging from 500m for red kite, golden eagle, hen harrier, osprey and peregrine to 1000m for white-tailed eagle.

3.2 Nightjar *Caprimulgus europaeus*

3.2.1 Legal Status

As with all wild birds, nightjar receives general protection under Section 1 of the Wildlife and Countryside Act 1981 (as amended) which makes it an offence to intentionally kill, injure or take any wild bird or take, damage or destroy the nest (whilst being built or in use) or its eggs.

Nightjar is listed on Section 41 of The Natural Environment and Rural Communities (NERC) Act 2006 as a Species of Principal Importance for the conservation of biodiversity in England. Under Section 40 of the Act, every public authority must, in exercising its functions, have regard, so far as is consistent with the proper exercise of those functions, to the purpose of conserving biodiversity.

Nightjar is listed in Annex 1 of the EU ‘Birds’ Directive (Directive on the conservation of wild birds 79/409/EEC). The Directive requires EU member states to identify Special Protection Areas (SPAs) for rare or vulnerable species listed in Annex 1 of the Directive. The SPA suite for nightjars in the UK comprises 10 sites. 9 of these are in southern England and East Anglia; 1 is in Northern England: Thorne and Hatfield Moors SPA which is located approximately 75 km south-south-west of South Moor Farm.

[12] Grubb. T Y. & Bowerman, W. W. (1997) Variations in breeding bald eagle responses to jets, light planes and helicopters. Journal of Raptor Research, 31, 213-222.

3.2.2 *Conservation Status*

The most recent published estimate for the UK breeding population of nightjars in the UK was 4600 (males) in 2004; an increase of over 36% since 1992[13].

The nightjar population within North Yorkshire Moors Important Bird Area (IBA) was estimated to be 207 males in 2004[14].

Unpublished surveys and anecdotal information suggests that the nightjar population in North Yorkshire (including Dalby Forest) has increased significantly in recent years. A press release from the Forestry Commission in 2011[15] stated: "*The elusive Nightjar, under threat of extinction just 40 years ago, has once again returned to North Yorkshire's woodlands in record numbers. The nocturnal bird, famed for its churring love-call and aerobatic courtship dance, has made local Forestry Commission woods its key summer stronghold in northern Britain. A survey underway in 3,000-hectare (7,500-acre) Langdale Forest, between Whitby and Pickering, has so far recorded 73 churring males with two more areas to be checked, meaning last summer's record numbers are set to be toppled. Pickering-based Mick Carroll, from the Forest Bird Study Group, now estimates that there could be well over 500 Nightjar pairs in the 22,400-hectare (56,000-acre) public forest estate in North Yorkshire.*"

In 2009, nightjar was on the Red List of Birds of Conservation Concern[16] due to qualification under three categories:

1. Breeding Range Decline. Severe decline in the UK range, of more than 50%, as measured by number of 10 km squares occupied by breeding birds, over the longer-term.
2. SPEC status. Categorised as a Species of European Conservation Concern (SPEC 1, 2 or 3).
3. Breeding Localised. At least 50% of the UK breeding population found in 10 or fewer sites.

However, by 2014[17], nightjar had moved from the Red List to the Amber List thanks to the creation and management of suitable habitat, stimulated by species action plans. Nightjar currently qualifies for Amber List status under one category:

1. Breeding Range Decline. Moderate decline in the UK range, of more than 25% but less than 50%, as measured by number of 10 km squares occupied by breeding birds, over the longer-term.

At a European level, nightjar is listed as 'SPEC 2'[18], i.e. a species with an unfavourable conservation status in Europe (population threatened, declining, depleted from historical levels or found only in a few locations) and is concentrated in Europe (i.e. more than 50% of the global population occurs in Europe).

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13 Conway G, Wotton S, Henderson I, Langston R, Drewitt A, Currie F. (2007). Status and distribution of European Nightjars Caprimulgus europaeus in the UK in 2004. Bird Study (2007) 54, 98–111.

14 http://www.birdlife.org/datazone/sitefactsheet.php?id=2562

15 Forestry Commission. Friday 24th June 2011. https://www.birdguides.com/webzine/article.asp?a=2767

16 Eaton MA, Brown AF, Noble DG, Musgrove AJ, Hearn R, Aebischer NJ, Gibbons DW, Evans A and Gregory RD (2009) Birds of Conservation Concern 3: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man. British Birds 102, pp296–341.

17 Eaton MA, Aebischer NJ, Brown AF, Hearn RD, Lock L, Musgrove AJ, Noble DG, Stroud DA and Gregory RD (2015) Birds of Conservation Concern 4: the population status of birds in the United Kingdom, Channel Islands and Isle of Man. British Birds 108, pp708–746.

18 Burfield, I. & van Bommel, F. 2004. Birds in Europe: population estimates, trends and conservation status. Birdlife International, Cambridge.

3.2.3 General Ecology

Nightjars are nocturnal and feed primarily on moths and beetles in sustained lower-level aerial-pursuit[19]. Nightjars hunt at any time from dusk to dawn[20].

As a food gatherer, nightjars are wholly aerial but mainly fly in the lower airspace and otherwise mostly a ground bird, not only for nesting but also for day-time resting using tree branches and other perches less as bases for foraging than as song-posts and look-outs. They spend the daytime resting on the ground or on tree branches[19].

The main predators of nightjar in Britain appear to be species such as corvids (crows and allies) and foxes which predate nests. Predation of birds in flight is thought to be extremely rare.

Nightjars which breed in Britain spend their winters in Africa. They arrive in the south of England in April and in the north of England and central Scotland in May and early June. Nightjars traditionally nest in lowland heathland but will also breed in clear-felled coniferous plantations. They prefer areas with scrubby vegetation and the occasional taller tree from which males display by 'churring'.

An intensive study in the North York Moors[21] showed clear requirements for open ground to a minimum extent of 2 hectares and commonly for the presence of tall marginal trees. As described below, in southern England Bright et al[27] found that nightjars would nest in patches of heathland as small as 0.2 hectares provided additional suitable habitat was present elsewhere nearby. Brunner[22] found that woodland glades of less than 1 – 1.5 hectares were unlikely to support a breeding pair, while from 3.2 hectares upwards, 2 males may hold territories.

The nightjar's global distribution lies in the Palearctic where it breeds from North Africa and western Europe, widely across temperate regions of Eurasia as far as central Asia and western China[23]. Nightjars are highly migratory and birds leave temperate breeding areas to overwinter in Africa, where they are widely distributed south of the Sahara. Over half of the species' global breeding range lies in Europe, where it occurs in most countries, being absent only from Iceland and northern parts of Scandinavia. In the UK, Ireland and central Europe its distribution tends to be sporadic, reflecting the scattered availability of good breeding habitats[24].

Nightjars breeding in the UK are concentrated in southern and south-eastern England and East Anglia, with smaller numbers and lower densities occurring in Wales, the Midlands, north-east England and south-west Scotland[23].

Breeding habitats include heathland, often with scattered pine or birch, woodland edges and clearings, young forestry plantations and, particularly in south-east England, coppiced woodland. Forestry plantations are used up to 15–20 years after planting[25]. In clear-felled areas of Thetford Forest, nests have been found in a variety of habitats, including extensive, non-vegetated areas and sparse bracken[26]. Birds forage over a variety of habitats including

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[19] Perrins C and Cramp S (Eds). (1998). Birds of the Western Palearctic (BWP): Handbook of the Birds of Europe, the Middle East and North Africa. CD-ROM Edition, December 1998.

[20] Schlegel R (1967). Beitr. Vogelkde. 13, 145-190.

[21] Leslie R (1981). The North York Moors Nightjar (Caprimulgus europaeus) Survey 1980 Rep. Pickering.

[22] Brunner K. (1978). Anz. Orn. Ges. Bayern. 17, 281-291.

[23] http://jncc.defra.gov.uk/pdf/UKSPA/UKSPA-A6-97.pdf

[24] Hagemeijer W.J.M. & Blair M.J. (eds) 1997. The EBCC Atlas of European Breeding Birds: Their distribution and abundance. T & A Poyser, London.

[25] Bowden, C. G. R. and Green, R. E. (1994) The ecology of Nightjars on pine plantations in Thetford Forest. Unpublished report to Forestry Commission and Royal Society for the Protection of Birds, Sandy.

[26] Burgess NP, Evans CE (1989). A management case study: management of heathland for nightjars at Minsmere, Suffolk. RSPB, Sandy, Beds.

deciduous or mixed woods, orchards, gardens, riparian habitats and freshwater wetlands, heathland and young plantations[25].

Regarding the amount of suitable habitat (i.e. heathland or clear-felled plantation) required to sustain a breeding pair of nightjars, in England, Bright et al[27] found that nightjars were present on 327 heathland patches which ranged in size from 0.2 ha to 2874 ha. The minimum size of heathland patch containing more than one nightjar territory was 1.5 ha. The median density of nightjars on the heathland patches was 9.8 males per km^2. The likelihood of a patch being occupied increased with increasing area of heathland in the vicinity (area within 10 km). This study shows that patches of suitable habitat as small as 0.2 ha can support breeding nightjars but that isolated patches were less likely to support nightjars compared to patches close to other areas of suitable habitat.

3.2.4 *Background Information on the Effects of Disturbance*

Whilst there is plentiful evidence of adverse effects on the numbers of breeding nightjars as a result of direct human disturbance from walkers and dogs; we have found no published information regarding the effects of aircraft on nightjar.

When threatened at roost, adults rely on crypsis[28], adopting ‘cigar-posture’ with head moved forward and down with eyes closed to a slit. In this position, the bird remains motionless and usually allows approach to within a few metres (circa 5 metres) before finally flying up suddenly and giving alarm call[19].

Given the nightjar’s reliance on crypsis and its nocturnal behaviour, it is expected that this species will have relatively low levels of susceptibility to aerial predators during daylight hours and therefore aerial predators (and by inference, aircraft) are not likely to elicit regular ‘active’ predation-response effects (as defined by Ruddock and Whitfield[3]). It is likely that nightjars will tend to be largely tolerant of potential sources of disturbance during daylight hours unless the birds are approached to within a few metres (circa 5 metres). Nightjars may be less tolerant of airborne disturbance at night (it is understood that no nocturnal flights will be undertaken at this site).

For nightjar, Currie & Elliot[29] proposed safe (i.e. non-disturbing) working distances of 50 – 250m for forestry workers.

Ruddock and Whitfield[3] state that because breeding nightjars rely on their cryptic plumage to escape detection, estimates of static disturbance distances should be viewed with some scepticism because avoiding any movement is probably part of the suite of behaviours nightjars use to escape detection. This trait is also likely to lead to low active disturbance distances, with birds only flushing from the nest when an approaching potential predator is close. Surveys revealed that nightjars were flushed from nests only at distances of <10 m during incubation and 50 – 100m during chick rearing. These values were lower than those suggested by Currie & Elliott[29] (i.e. 50 – 250m). Although difficult for an observer to detect, however, passive disturbance is likely to occur at greater distances than could be revealed by the expert survey. Ruddock and Whitfield[3] suggest that detrimental effects of disturbance may occur at greater distances than implied by upper limits of active disturbance responses to an approaching human.

The published information clearly shows that nightjars are sensitive to daytime disturbance from people and dogs and that nightjars preferentially select undisturbed areas for nesting and day-

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[27] Bright JA, Langston RHW, Bierman S (2007). Habitat associations of nightjar Caprimulgus europaeus breeding on heathland in England. RSPB Research Report No 25. A report by the Royal Society for the Protection of Birds, as part of a programme of work jointly funded by the RSPB and Natural England, October 2007.

[28] Crypsis is the ability of an animal to avoid observation or detection by other animals, e.g. by camouflage and/or remaining motionless.

[29] Currie, F. & Elliott, G. (1997). Forests and Birds: A Guide to Managing Forests for Rare Birds. Forestry Authority, Cambridge and Royal Society for the Protection of Birds, Sandy, UK.

time resting. However, observations of nightjars hunting over gardens, roads, orchards and even around street-lights at night suggests that they may be more tolerant of human presence whilst airborne at night.

Lowe at al[30] examined habitat use and reproductive success over 10 years in a breeding population on 1335 ha of managed land in Nottinghamshire, England. The study site was divided into a heavily disturbed section and a less disturbed section of equal habitat availability, forming a natural long-term experiment. They found that overall nightjar density was significantly lower and there were significantly fewer breeding pairs in the heavily disturbed habitat compared with the less disturbed habitat. However, average breeding success per pair, in terms of eggs and fledglings produced, was not significantly different between the two sections across years. The findings suggest that human recreational disturbance may drastically alter settlement patterns and nest site selection of arriving females in nightjar and may reduce the utility of apparently suitable patches of remnant and created habitat.

English Nature[31] compared the breeding success of nightjars on several sites in Dorset with varying levels of public access. Sites with no public access showed significantly higher breeding success than sites with open access. On sites with public access, territory centres and nest sites occurred considerably further away from urban development. In addition, nests that did succeed were located significantly further away from paths. The probability of nest survival was 12%. The key cause of nest loss was predation (60% of all nests failed, 93% due to predation). The evidence from nest remains, post predation, suggested that 63% of failed nests were predated by corvids. The results therefore suggest that predation and disturbance may be linked, the possible mechanism being that birds nesting close to paths are flushed from the nest more often, betraying the nest site to predators. Anecdotal evidence suggests that dogs off leads may be a particular cause for concern.

3.3 Goshawk *Accipiter gentilis*

3.3.1 Legal Status

Goshawk is listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended) which means that it receives special protection which makes it an offence to intentionally or recklessly disturb this species while building a nest or in, on or near a nest containing eggs or young; or to disturb dependent young of this species. This protection is additional to the general protection afforded to all wild birds under the Act as described above for nightjar.

3.3.2 Conservation Status

Goshawk is on the Green List of Birds of Conservation Concern (BoCC) as the species meets none of the criteria for inclusion on the Red or Amber lists.

The British breeding population is estimated to be approximately 400 pairs[32] although there is anecdotal evidence that the population may now be higher than 400 pairs. The population in the North York Moors area is not known.

3.3.3 General Ecology

Goshawk is a large raptor which, in Britain, breeds primarily in large areas of plantation woodland. Goshawk is active during daylight hours and hunts for its prey items (largely pigeons, corvids, thrushes and starlings although many other species are taken) by rapid flight, often through woodland.

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[30] Lowe, A., A. C. Rogers, and K. L. Durrant. 2014. Effect of human disturbance on long-term habitat use and breeding success of the European Nightjar, Caprimulgus europaeus. Avian Conservation and Ecology 9(2): 6.

[31] English Nature Research Reports No. 483. (2002). The impact of human disturbance on the breeding success of nightjar Caprimulgus europaeus on heathlands in south Dorset, England. English Nature, Peterborough, 2002.

[32] http://blx1.bto.org/birdfacts/results/bob2670.htm

Those goshawks which breed in Britain remain resident year-round. Populations breeding in northern Europe are partially migratory, and some individuals may reach Britain from Scandinavia.

Goshawks defend only the nesting territory and hunt within large overlapping home ranges. Home range sizes and nest densities vary with the availability of suitable prey and woodland. In lowland Britain, the distance between adjacent nests in woodland blocks varied from 1–3.7 km (Anon., 1989).

Nest sites are usually placed in areas with a high density of mature trees and well developed canopy cover, surrounded by relatively open woodland[33].

3.3.4 Background Information on the Effects of Disturbance

Ruddock and Whitfield[3] state that, although apparently highly dependent on extensive tracts of native forests in North America, goshawks in Europe are highly adaptable to human-altered landscapes and in the absence of illegal killing and other forms of persecution are tolerant of intense human activities in some areas, including occupying urban habitats with relatively successful productivity[34]. Goshawks in Britain generally avoid housing and public roads at distances greater than 200m but goshawk colonisation of large cities elsewhere in Europe is a demonstration that the presence of humans per se does not prevent successful breeding[3].

Urban-breeding goshawks are remarkably tolerant of human and the flushing distance for perched hawks is typically as low as 10 – 20 metres [3, 34].

Brooding females in urban territories may not flush from the nest even when the nest tree is struck with a stick[3, 34]. Rutz et al[34] suggested that tolerance shown by urban pairs was unlikely to be a regular occurrence in rural pairs although it had been recorded, albeit infrequently[3].

For goshawk, Currie & Elliot[29] proposed safe (i.e. non-disturbing) working distances of 250 – 400m for forestry workers.

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[33] Petty, S.J. (1996). Reducing the disturbance to goshawks during the breeding season. Forestry Commission Research Information Note, 267. Forestry Commission, Edinburgh.

[34] Rutz, C., Bijlsma, R.G., Marquiss, M. & Kenward, R.E. (2006). Population limitation in the northern goshawk in Europe: a review with case studies. Studies in Avian Biology, 31, 158–197.

4 Survey Results

4.1 Desk Study

4.1.1 Protected Sites

North York Moors Special Protection Area (SPA) lies approximately 6.02 km to the north-west of the site. The SPA Qualifying Features are: merlin *Falco columbarius* (breeding); and European golden plover *Pluvialis apricaria* (breeding).

Troutsdale and Rosekirk Dale Fens Site of Special Scientific interest (SSSI) lies approximately 2.00 km south of the site. The SSSI citation describes the site's value as fen habitat.

Bride Stones SSSI lies approximately 2.76 km west of the site. The SSSI citation describes the site's value in geological terms and for the habitats present.

The site is located within North Yorkshire Moors Important Bird Area[35] (IBA). IBA is a non-statutory designation for areas of key importance for particular species. North Yorkshire Moors IBA is designated as an IBA due to its populations of nightjar *Caprimulgus europaeus* (population estimate 207 males in 2004), merlin *Falco columbarius* (population estimate 40 breeding pairs in 1996) and European golden plover *Pluvialis apricaria* (population estimate 141 breeding pairs in 2000)[35].

4.1.2 Bird Species Records

Information provided by NEYEDC is reproduced at Appendix 2. NEYEDC provided one record of nightjar, dated 30th June 1992, at grid reference SE910907 which is approximately 300 metres north of the northern end of the proposed runway. NEYEDC provided no records of goshawk from the search area.

Despite several attempts to contact the Forestry Commission (Pickering office) to obtain information regarding nightjar and goshawk in Langdale Forest and the wider area, no information had been received at the time of writing.

4.1 Field Survey

4.1.1 Nightjar

The field survey was undertaken at a time of year when nightjars have migrated to Africa and therefore no evidence of nightjar was observed during the field survey.

The areas within the survey area have been assessed in terms of their suitability to support nightjars.

Areas assessed as containing habitat potentially capable of supporting breeding nightjar are shaded orange in Appendix 3. These areas comprise former coniferous plantation which has been clear-felled no more than 20 years ago and where the canopy of planted or naturally colonising trees has not yet become too dense to potentially support breeding nightjars.

Areas assessed as unsuitable nesting habitat for nightjar but potentially suitable for foraging are shaded bright green in Appendix 3. These areas comprise habitats such as forestry rides, forestry edges, deciduous or mixed woodland, riparian habitats and areas of young coniferous plantation.

As shown in Appendix 3, within 500 metres of the proposed sub-500ft flight path, the following areas of potentially suitable nightjar habitat have been identified:

- 4 patches of potentially suitable breeding habitat covering approximately 11.5ha; 2.7ha; 2.5ha; and 0.6ha respectively, 17.3 hectares in total.

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[35] http://www.birdlife.org/datazone/sitefactsheet.php?id=2562

- Potentially suitable foraging habitat covering approximately 22.3 hectares in total.

The previous record of nightjar supplied by NEYEDC relates to the orange-shaded patch of potentially suitable breeding habitat approximately 175 metres north of the northern end of the proposed runway.

The four identified patches of potentially suitable breeding habitat within 500m of the proposed sub-500ft flight path could potentially each support breeding nightjars. Given the known variability in the breeding density of this species; in the absence of surveys during the breeding season, it is not possible to determine how many pairs of breeding nightjars may occur in these areas.

Nightjars breeding within the four identified patches of potentially suitable breeding habitat, plus nightjars breeding elsewhere within 2-3km radius or more, may forage within the identified 22.3ha of potentially suitable foraging habitat identified. Habitats elsewhere within 500m of the proposed sub-500ft flight path have been assessed as largely unsuitable for nightjar, although these areas could be used on an occasional basis, e.g. for nocturnal passage/commuting flights.

4.1.2 Goshawk

During the field survey, no evidence of goshawk was observed. Occasional evidence of a raptor-kill was found (i.e. remains of plucked pigeons), but these could not conclusively be attributed to goshawk.

The areas within the survey area have been assessed in terms of their suitability to support goshawk.

Areas assessed as containing habitat potentially capable of supporting breeding goshawk are shaded orange in Appendix 4. These areas comprise mature woodland. Some parts of the study area contain habitats highly suitable for goshawk, i.e. dense mature coniferous plantation with very low levels of human disturbance surrounded by extensive tracts of woodland including some areas with less-dense tree cover but Appendix 4 shows all areas assessed as potentially suitable nesting habitat.

Whilst goshawks generally hunt in woodland in Britain, this species can hunt over open-ground also. Whilst the large expanse of grassland near the runway is considered to provide sub-optimal hunting ground for goshawk, it is possible that this fast-moving and relatively far-ranging species could hunt anywhere within the study area.

As shown in Appendix 4, within 500 metres of the proposed sub-500ft flight path, the following areas of potentially suitable goshawk nesting habitat have been identified (the entire area is considered to provide potentially suitable, although not necessarily optimal hunting habitat for goshawk):

- Potentially suitable nesting habitat covering approximately 165 hectares.

NEYEDC provided no previous records of goshawk within the search area.

Given the known variability in the breeding density of this species; in the absence of surveys during the breeding season, it is not possible to determine how many pairs of breeding goshawk may occur in these areas. It is possible that up to 4 breeding pairs of goshawk could occur within 500 metres of the proposed sub-500ft flight path, although the actual number, if present, may be much less than 4 pairs.

Goshawk breeding within the identified suitable habitat areas may hunt throughout the entire area.

5 Conclusions

5.1 Nightjar

Nightjar is known to occur within the vicinity of the proposed runway with a previous record dated 1992 from approximately 300 metres north of the northern end of the proposed runway. This study has identified four patches of potentially suitable breeding habitat covering a total of approximately 17.3 hectares within 500m of the proposed sub-500ft flight path and a further approximately 22.3 hectares of potentially suitable foraging habitat within the same area.

There is no known published research on the effects of aircraft on nightjar although there is plentiful evidence of the confirmed adverse effects of disturbance from humans and dogs on nightjar in England.

The ecology of nightjar, including its nocturnal behaviour and its use of crypsis to avoid detection, suggests that this species may be relatively tolerant of daytime flights of light aircraft.

There is evidence of other bird species becoming habituated to disturbance from aircraft. Birds appear to become better habituated to aircraft flight activity where the flights are ‘regular’ in terms of their occurrence, type of aircraft and flight path. The proposed runway is anticipated to involve a fairly regular pattern of flight activity, i.e. involving flights of the same/similar type of aircraft along a regular flight path and without the erratic flight activity which would be associated with a pilot-training airfield.

As mitigation for nightjar, it may be appropriate to avoid flight activity during the periods 30 minutes after dawn and 30 minutes before sunrise during the main nightjar breeding period of May to August inclusive. Additionally, flight activity in the vicinity of suitable breeding habitat (clear-fell) should be limited to direct ‘in-and-out’ flights rather than circling and/or erratic flight activity at low altitude.

5.2 Goshawk

Goshawk could to breed within the vicinity of the proposed runway although NEYEDC did not provide any previous records from the search area. This study has identified potentially suitable nesting habitat totalling approximately 165 hectares within 500m of the proposed sub-500ft flight path. It is possible that up to 4 breeding pairs of goshawk could occur within 500 metres of the proposed sub-500ft flight path, although the actual number, if present, may be much less than 4 pairs.

There is no known published research on the effects of aircraft on goshawk although there is evidence that this species is highly tolerant of anthropogenic disturbance, particularly in continental Europe.

There is evidence of other bird species becoming habituated to disturbance from aircraft. Birds appear to become better habituated to aircraft flight activity where the flights are ‘regular’ in terms of their occurrence, type of aircraft and flight path. The proposed runway is anticipated to involve a fairly regular pattern of flight activity, i.e. involving flights of the same/similar type of aircraft along a regular flight path and without the erratic flight activity which would be associated with a pilot-training airfield.

As a best practice measure in order to minimise the potential for disturbance of goshawk, the runway operator liaise with local Forestry Commission ornithologists on a regular basis so that pilots can aim to avoid flying close to any known goshawk nest sites, although it is important that details of goshawk nest sites remain confidential due to the threat of egg-collectors. Additionally, flight activity in the vicinity of suitable nesting habitat (mature dense woodland) should be limited to direct ‘in-and-out’ flights rather than circling and/or erratic flight activity at low altitude.

Appendix 1. Photos

Photo 1. Looking north-east along runway

Photo 2. Woodland-edge habitats which may be used by nightjar for feeding

Photo 3. Clear felled plantation – suitable nightjar breeding habitat

Photo 4. Woodland 'ride' providing suitable nightjar feeding habitat

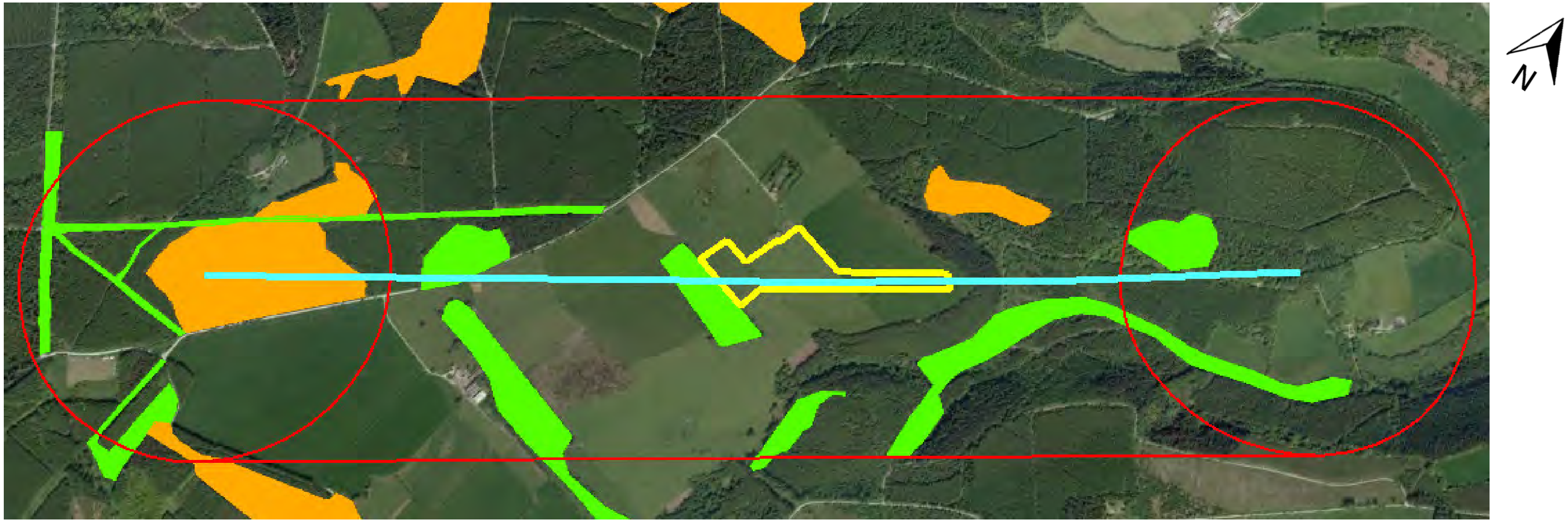
Photo 5. Woodland-edge habitat alongside road providing suitable nightjar feeding habitat

Photo 6. Formerly clear felled habitat in foreground (bracken with immature trees) provides potentially suitable breeding habitat for nightjar. Mature plantation in distance provides suitable breeding habitat for goshawk.

Appendix 2. Information provided by NEYEDC

Scientific Name	Common Name	Taxonomic group	Location	Grid Reference	Custodian	Survey	Recorder	Dated	Measurement
Accipiter nisus	Eurasian Sparrowhawk	bird	North Yorkshire	SE888889	neyedc.org.uk	Gordon Simpson's bird records	Simpson, Gordon (Mr)	10/05/1967	
Caprimulgus europaeus	European Nightjar	bird	Scarborough District	SE910907	neyedc.org.uk	Bird records from local ornithological groups	Unknown	30/06/1992	
Cuculus canorus	Common Cuckoo	bird	North Yorkshire	SE893888	neyedc.org.uk	Gordon Simpson's bird records	Simpson, Gordon (Mr)	31/08/1966	
Muscicapa striata	Spotted Flycatcher	bird	North Yorkshire	SE916917	neyedc.org.uk	Gordon Simpson's bird records	Simpson, Gordon (Mr)	09/05/1967	
Poecile montanus	Willow Tit	bird	Bickley [Deep Dale]	SE9121090800	neyedc.org.uk	Ecological Consultant Survey Data: Wold Ecology R.B. Ltd	Surveyor [Wold Ecology]	12/07/2014	
Poecile montanus	Willow Tit	bird	Bickley [Deep Dale]	SE9121090800	neyedc.org.uk	Ecological Consultant Survey Data: Wold Ecology R.B. Ltd	Surveyor [Wold Ecology]	12/07/2014	
Pyrrhula pyrrhula	Common Bullfinch	bird	North Yorkshire	SE9291	neyedc.org.uk	Gordon Simpson's bird records	Simpson, Gordon (Mr)	14/02/1967	
Strix aluco	Tawny Owl	bird	North Yorkshire	SE8888	neyedc.org.uk	Gordon Simpson's bird records	Simpson, Gordon (Mr)	18/05/1967	

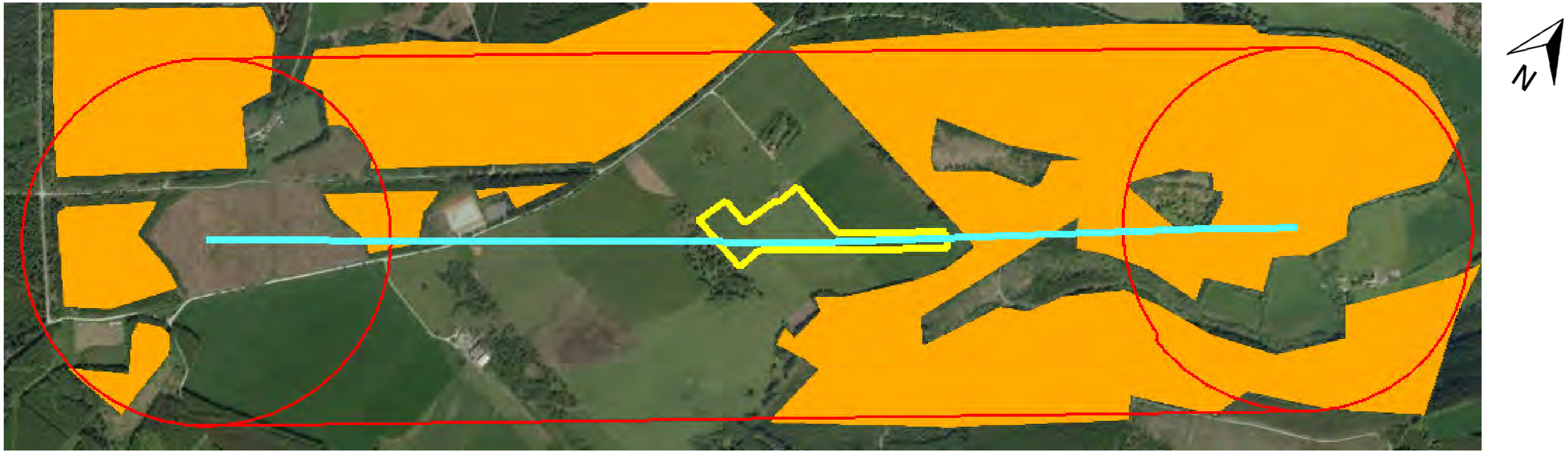
Appendix 3. Map Showing Suitable Nightjar Habitat



Key:

- Proposed runway
- Proposed sub-500ft flight path
- 500m buffer around sub-500ft flight path
- Clear-felled plantation assessed as potentially suitable breeding habitat for nightjar
- Rides, scrub and woodland assessed as potentially suitable feeding habitat for nightjar

Appendix 4. Distribution of Suitable Goshawk Habitat



Key:

- Proposed runway
- Proposed sub-500ft flight path
- 500m buffer around sub-500ft flight path
- Mature woodland assessed as potentially suitable nesting habitat for goshawk

Appendix 5. Disturbance Effects of Aircraft on Birds. English Nature Birds Network Information Note

ENGLISH NATURE

Birds Network

INFORMATION NOTE

Disturbance effects of aircraft on birds

Introduction

The purpose of this note is to examine the evidence of impacts on bird populations resulting from disturbance caused by aircraft. This includes an assessment of the effects of different aircraft types and their proximity, altitude and frequency of flight. Other important factors discussed are differences in sensitivity shown by different species and flock sizes and behavioural responses such as habituation and facilitation. The evidence for harmful disturbance caused by aircraft is then presented under a number of categories of impacts including: increased energy expenditure, reduced foraging rates, reduced breeding success and increased predation. Finally, a number of measures that may reduce disturbance impacts are described, including changes to flight altitudes and the use of no-fly zones.

Before discussing the impact of disturbance caused by aircraft, it is important to define the meaning of disturbance in this context. Disturbance can be defined as 'any situation in which a bird behaves differently from its preferred behaviour' or 'any situation in which human activities cause a bird to behave differently from the behaviour it would exhibit without the presence of that activity'. Here we are concerned mainly with the latter definition, although natural causes of disturbance (weather, predators) will always play an important role and may result in even greater impacts when combined with disturbance caused by human activities.

A gradient or hierarchy of behavioural responses to disturbance shown by birds is described by much of the work presented below. For example, the lowest detectable response is for a bird to briefly look in the direction of the source of disturbance before resuming its previous activity. The other extreme would be for a flock of birds to fly away from an area and to not return for several hours, or even days. Such high levels of disturbance resulting in flushing or escape behaviour are quite likely to have an effect, for example, by increasing the energy expenditure of wintering birds. The more difficult question to answer is at what point along the lower end of the gradient does the disturbance result in an impact on a population. For example, repeated exposure to lower levels of disturbance may result in increased stress which, in turn, may cause lower breeding success.

Useful introductions to bird disturbance and further information on the above issues can be found in Davidson & Rothwell (1993) and Hill *et al* (1997).

Disturbance caused by aircraft

The degree of disturbance caused by aircraft relative to other sources of disturbance varies greatly. For example, Grubb & Bowerman (1997) cite results from research on the human disturbance of Bald Eagles where aircraft caused the lowest frequency of behavioural response of the five disturbance groups evaluated (vehicle, pedestrian, aquatic, noise, aircraft). By contrast, small aircraft and pedestrians were the most important sources of disturbance in a study of waders at a high-tide roost on Terschelling, the Netherlands, summarised by Smit & Visser (1993). Bélanger & Bédard (1989) also concluded that the time spent in flight and the time taken to resume feeding by staging Snow Geese in the Montmagny bird sanctuary, Québec, were greater after disturbance by aircraft than after any other type of disturbance encountered in their study.

Disturbance caused by different types of aircraft

Differences in response to different types of aircraft have also been identified. The work on Bald Eagles by Grubb & Bowerman (1997) established that the eagles in their study showed a much greater response to helicopters (47% of all potential disturbance events) than to jets (31%) and light planes (26%). This is consistent with Platt (1977) who recorded that helicopter flights at 160 m altitude or less disturbed all adult Gyrfalcons being tested. Visser (1986) also compared the effects of jets and helicopters on roosting waders on Terschelling and found that helicopters disturbed birds more frequently and over longer distances than jets, even though the activities from jets were accompanied by weapon testing and high sound levels. Similar results were found in a study of small aircraft flying over wader roosts in the German Wadden Sea (Heinen 1986). In this study helicopters disturbed most often (in 100% of all potentially disturbing situations), followed by jets (84%), small civil aircraft (56%) and motor-gliders (50%). These data confirm the widely accepted view that helicopters are the most disturbing type of aircraft (Watson 1993).

The effects of ultra light aircraft are briefly described by Smit & Visser (1993). Although very little research on the effects of ultra lights has been carried out so far, there is evidence that they can cause significant disturbance, probably because of the low altitude at which they operate and the noise they produce. For example, the numbers of roosting and foraging Bewick's Swans close to an ultra light air strip in the Delta area of the Netherlands dropped from 1,400-4,300 in 1986-88 to only a few birds in 1989, after the strip has been used for one year (Smit & Visser 1989). However, this must be compared with the results of a study on the effects of microlights on wintering Pink-footed Geese near the Ribble Estuary (Evans 1994). Although only based on six observations during January to March, this study concluded that birds rapidly habituated to the presence of microlights landing and taking off from an air-strip only 250 m from their feeding areas.

Effects of proximity and frequency of aircraft flights

The altitude and lateral distance of aircraft have been shown to be important factors affecting bird disturbance. In a model of helicopter disturbance of moulting Black Brant geese it was shown that altitude strongly influenced the results, as measured by the number of birds disturbed and by weight loss. At an altitude of 1220-1830 m (depending on helicopter size) there was no predicted weight loss. However, helicopters at 915-1065 m disturbed most birds along all the flight routes. The greatest weight loss was predicted to occur with helicopters at 305-460 m (Miller 1994). Work carried out by Ward *et al* (1994) also confirms an effect of aircraft altitude for staging Black Brant on the Izembeck Lagoon, Alaska. It was found that large planes flying above 610 m had little effect, causing only brief responses by relatively few birds. Fixed-wing aircraft caused the greatest flight response when passing at less than 610 m and less than 0.8 km lateral distance to the flock. Similarly, Owens (1977) reported that wintering Black Brant showed a greater response to fixed-wing aircraft at less than 500 m altitude and less than 1.5 km lateral distance. Aircraft disturbed Black Brant at greater distance than other disturbance types and affected more geese over a larger area than other stimuli. Again, helicopters caused the greatest response duration of all aircraft types. Jensen (1990) found that helicopters had to fly at over 1070 m to avoid disturbing moulting Black Brant. Mosbech & Glahder (1991) suggest that *distant* helicopters are less disturbing when at low altitudes as they are likely to transmit less noise than helicopters at a higher flying level.

Observations of cliff-nesting seabirds on the coast of Aberdeenshire by Dunnet (1977) showed that helicopters and fixed-wing aircraft flying at 150 m above sea level and 100 m above the cliff top caused no detectable effect on the attendance of breeding Kittiwakes and Guillemots at their nests during egg-laying and hatching. However, it was noted that the cliffs are on the normal route of air traffic and thus the birds may have become habituated. No observations were made of aircraft at less than 100 m above the cliff top. Very different responses by seabirds, presumably not habituated, have been recorded on Ailsa Craig in the Firth of Clyde. During one incident a Hercules transport aircraft made successive flights about 200 m above the summit of the island. This caused an entire gannet colony to scatter for about an hour, leaving eggs and small chicks exposed to predation (Zonfrillo 1992).

Smit & Visser (1993) cite further information on the effects of small civil aircraft on roosting shorebirds at different altitudes:

- Aircraft at an altitude of more than 300 m at various sites in the German Wadden Sea disturbed birds in 8% of all potentially disturbing situations, with those flying at 150-300 m in 66% of the cases and those flying at less than 150 m in 70% (Heinen 1986).

- Disturbance in another study was always registered at 150 m altitude and, at a height of 300 m, there was still disturbance within a radius of 1,000 m (Baptist & Meininger 1984). It has been estimated that an aircraft passing over at 150 m creates a disturbed area of more than 15,000 ha (Meer 1985).

- Disturbance can still be detected when aircraft pass at 1000 m altitude (Werkgroep Waddenzee 1975).

- In addition to altitude, the behaviour of aircraft also influences disturbance levels. Flying high in a straight line leads to smaller effects than flying low or with unpredictable curves (Boer *et al* 1970).

Experimental studies of the effects of microlights on Pink-footed Geese (Evans 1994) indicated that they caused no detectable disturbance of geese, Lapwing, Curlew or Golden Plover when over 1000 ft. Signs of disturbance were first noted at around 500 ft.

Turning to the effect of lateral distance of aircraft, a study of the effects of low level jets on nesting Osprey in Labrador, Canada, could not identify any significant disturbance to birds from over-flights as close as 0.75 nautical miles (Trimper *et al* 1998). However, the Ospreys in this study may have habituated to aircraft during exposures in previous years. Visser (1986) detected the disturbance of roosting waders on Terschelling by jets flying up to 1000 m away. Brent Geese on the Essex coast were put to flight by any aircraft up to 1.5 km away when at altitudes below 500 m (Owens 1977).

Research has also been carried out to assess the effect of the frequency of aircraft flights on birds. For example, a study of staging Snow Geese in the Montmagny bird sanctuary, Québec, found that a rate of greater than two disturbances per hour during a single day could reduce the numbers of geese present on the site the following day (Bélanger & Bédard, 1989). Simulations of the effects of over-flights on moulting Black Brant also showed that increasing flight frequency usually caused greater impact on the birds through increased weight loss (Miller 1994). Similarly, experiments on feeding waders on tidal flats on Terschelling showed that 10 minutes after a single disturbance by a small plane at 360 m altitude bird numbers had returned to the same level as prior to disturbance. However, a plane passing twice, at 450 and 360 m respectively, caused a stronger effect, with only 67% of original number of Oystercatcher and 87% of the Curlew returning after 45 minutes (Glimmerveen & Went 1984).

Effect of noise

There has been little work on the effects of aircraft noise on birds. Busnel (1978) states that some species, such as gulls on airfields, breed close to extremely loud man-made noises without ill effects. Birds are assumed to habituate to the frequent loud noises of landing and departing aircraft, and only unusually loud noises are known to cause a reaction of alarm in these circumstances. Similarly, during the study by Owens (1977), Brent Geese quickly became habituated to most sounds, including extremely loud but regular bangs made during weapon testing. In another study of the effects of pre-recorded aircraft noise on nesting seabirds on Australia's Great Barrier Reef it was found that Crested Terns showed the maximum response of preparing to fly or flying off at exposures of greater than 85 dB(A). However, a scanning behaviour involving head-turning was observed in nearly all birds at all levels of exposure down to 65 dB(A), a level only just above that of the background noise (Brown 1990). It is not known what effect repeated exposure to lower noise levels can have on birds, although Fletcher (1988) found that low level jet and helicopter over-flights can cause physiological changes in domestic animals that may represent symptoms of stress.

Work by Mosbech & Glahder (1991) found that moulting geese in north-eastern Greenland showed signs of disturbance before helicopters were visible and that, typically, the noise stimuli alone disturbed the geese. Trimper *et al* (1998) found that nesting Osprey exhibited a similar response, staring at an approaching aircraft before it was audible to observers. There is also circumstantial evidence associating a near total hatching failure of Sooty Terns nesting on the Dry Tortugas Islands with sonic booms produced by low-flying military jets (reviewed in Bell 1972). However, Schreiber & Schreiber (1980) investigated sonic boom effects on colonial nesting gulls and cormorants and concluded that, compared to a human walking into a colony, a sonic boom had a minimal effect. Further work is needed to examine the combined effects of visual and acoustical stimuli. For example, trial balloon flights during a study by Brown (1990) indicated additional or interactive effects from the visual stimulus. In situations where background noise from natural sources is continually high the visual stimulus may have a greater effect.

Sensitivity of different species and effect of flock size

Significant variations in the sensitivity of different species have been observed during studies of the effects of aircraft on birds. For example, during observations of roosting waders on Terschelling, the Netherlands, it was found that Oystercatchers were rather tolerant of aircraft disturbance and Bar-tailed Godwits and Curlews were less so (Visser 1986). Different responses were also found during a study of coastal waterfowl in the German Wadden Sea. Brent Geese were amongst the most strongly reacting species (being disturbed in 64-92% of all potentially disturbing situations), together with Curlew (42-86%) and Redshank (70%), with Shelduck (42%) and Bar-tailed Godwit (38%) reacting less often (Heinen 1986). However, identifying consistent trends within species is difficult, as shown by another study of waders on Terschelling by Glimmerveen & Went (1984) where the recovery time following disturbance caused by a small air plane was greater for Oystercatcher (30 minutes before feeding resumed) than Curlew (7 minutes).

The relationship between flock size and disturbance was noted by Bélanger & Bédard (1989) when disturbance rates for staging Snow Geese were higher when more birds were present. Similarly, Owen (1977) observed that larger flocks of Black Brant geese took flight at a greater distance than did smaller flocks when approached by people, and Madsen (1985) observed the same reaction in staging Pink-footed Geese in Denmark. Disturbance behaviour of flocks is largely determined by the behaviour of the most nervous members of the group. Take-off of only a few birds may cause the entire flock to take flight, and the larger the flock the more chance of it containing a higher number of especially susceptible individuals. Thus, species that form large flocks may be more vulnerable to disturbance from aircraft.

Habituation and facilitation

The absence of any visible response of some species to aircraft suggests that, under certain circumstances, habituation may take place. The process of 'learning' that a particular stimulus is not associated with risk is probably encouraged by a more or less constant and predictable exposure to that stimulus. This may be the reason for the presence of Lapwings, gulls and Starlings at airfields where the movements and sound levels of planes are very predictable (Burger 1981). Similarly the habituation of nesting Ospreys to human activity has been shown to vary depending on the frequency and type of disturbance (Daele & Daele 1982). Ospreys nesting near humans, highways and the approach corridors for aircraft habituated to those activities, whereas others nesting farther from humans were less tolerant (Mullen 1985).

The importance of 'predictable' stimuli is illustrated in a study of feeding and roosting waders at Texel, the Netherlands, where it was found that a high degree of habituation had occurred to helicopters passing over at a frequency of 2-3 per hour at 100-300 m altitude. However, 'unusual' types of plane, which show up at low frequencies, still had strong effects (Smit & Visser 1993). This study suggests that birds are able to distinguish between types of plane as they do between aerial predators. Koolhaas *et al* (1993) note that habituation is only likely to develop in those individuals that are persistent in using an area throughout the season. Furthermore it is likely that birds never habituate to some types of disturbance. For example, studies of the effects of shooting ranges on roosting waders on Vlieland, the Netherlands, suggest that certain species could not habituate and, as a result, moved to alternative sites (Tanis 1962). Similarly, in a study of wintering Dark-bellied Brent Geese it was noted that, although birds quickly became habituated to most sounds, they never habituated to small, low-flying aircraft (Owens 1977). Jensen (1990) also found that moulting Black Brant geese did not habituate to over-flights.

The opposite to habituation, referred to as facilitation, may also occur when a combination of disturbing stimuli leads to an impact that far exceeds the effect that each activity alone would have had. For example, a study by Smit & Visser (1993) at Texel showed that, following exposure to an unusual aircraft type, otherwise habituated birds became more vulnerable to other forms of disturbance. Thus, an over-flying Grey Heron could cause a panic reaction much greater than would occur under normal conditions. A similar effect was found by Küsters & Raden (1986) on Sylt, Germany, where over-flying jets appeared to have greater effects when wind surfers had previously been in the area. Thus, the effect of facilitation is that birds become much more sensitive to relatively low levels of disturbance.

Impacts of aircraft disturbance on bird populations

As described above, the response of birds to disturbing events depends on a wide range of factors. These include the level of disturbance, reactions of other birds nearby, flock size and knowledge from earlier experiences (habituation and facilitation). Additional factors determine either their willingness to remain in the same place (scarcity of food, adverse weather, physiological condition of individual birds) or their motivation to leave for another place (daily and annual patterns of movement related to time of year and tidal level, or the presence of alternative sites). For this reason it is difficult to accurately predict the response of birds to different sources of disturbance. However there is evidence that, under certain circumstances, disturbance can have serious consequences for bird populations. The evidence of disturbance-related effects on bird populations is presented under the following categories of impacts.

Reduced food intake rates

There is general evidence that disturbance can significantly reduce food intake rates. For example, Beliën & Brummen (1985) found that birds forced out from preferred feeding areas may often simply wait until the source of disturbance has disappeared before resuming feeding. This was shown by the experimental disturbance of a single Oystercatcher. The bird was forced out from its preferred feeding site to another area where, despite the presence of other feeding birds, its intake rate dropped to almost zero. These results are confirmed by Hooijmeijer (1991) during similar work on Oystercatcher at Texel, the Netherlands. This showed that resting and walking during disturbance become the more dominant behaviour than feeding. Also, the food intake rate during the recovery period following disturbance was much higher than normal, presumably a result of birds trying to compensate for the loss of feeding time. Similarly, in response to frequent helicopter disturbance, the amount of time spent grazing by Pink-footed Geese in Northeast Greenland was decreased (Mosbech & Glahder 1991). Instead, the geese spent more time on the water and resting on ice floes. It was concluded that helicopter disturbance had a drastic impact on the time budget of Pink-footed Geese in this area.

Obviously, the impact of reduced intake rates will depend on other factors, including the physiological condition of the disturbed birds and their ability to compensate, for example, by feeding at night. This is illustrated by a simulation of the impact of helicopter flights on staging Black Brant geese which indicated that disturbance could result in significant weight loss (Miller 1994). Taylor (1993) found that Black Brant nearing the completion of wing moult are 'nutritionally emaciated' and that, for birds already in such poor condition, the additional loss of weight resulting from disturbance could result in abnormal or incomplete moult, if not decreased survival. Concerning compensation for reduced intake rates, Jensen (1990) suggested that gut capacity and passage rates and forage digestibility might limit the ability of Black Brant to compensate for lost feeding.

Increased energy expenditure

A potentially serious consequence of the extra flights needed to escape sources of disturbance is that energy expenditure will increase. The energetic costs of man-induced disturbance to staging Snow Geese in the Montmagny bird sanctuary, Québec, have been estimated by Bélanger & Bédard (1989). Human activities here accounted for over 80% of all disturbances recorded, with hunting and over-flying aircraft ranked highest. Two responses of birds to disturbance were considered: birds fly away but promptly resume feeding; and birds interrupt feeding altogether. The average rate of disturbance (1.46/hr) for the first response was estimated to result in a 5.3% increase in hourly energy expenditure combined with a 1.6% reduction of energy intake. The disturbance for the second, more prolonged, response was estimated to result in a 3.4% increase in hourly energy expenditure and a 2.9% reduction of energy intake. A conclusion from this study is that high levels of disturbance may have harmful energetic consequences for Snow Geese in Québec. More than two disturbances per hour may cause an energy deficit that no behavioural compensatory mechanism (such as night feeding) can counterbalance. Davis & Wiseley (1974) carried out similar work and claimed that an average seasonal disturbance rate of one event every two hours would cause a reduction of 20.4% in the energy reserves of staging Snow Geese. White-Robinson (1982) noted that wintering Black Brant geese increased their energy expenditure by 15% because of flights in response to disturbance.

Decreased breeding productivity

Disturbance caused by aircraft can have a range of impacts on breeding birds. Harmful effects include interference with courtship and initial nesting activities, the loss of eggs and chicks as a result of predation or exposure to adverse weather, and greater chick mortality due to starvation or premature fledging. However, the linkage between disturbance and decreased breeding productivity is not always clear and often it is not possible to conclusively show adverse effect. For example, the study by Dunnet (1977) of cliff-nesting seabirds found no evidence that aircraft affected incubating and brooding Kittiwakes, though habituation may have influenced the results. Some of the most dramatic evidence comes from 'catastrophic' incidents of the type described at Ailsa Craig (Zonfrillo 1992) where a low over-flight by a Hercules transport aircraft resulted in the estimated loss of 2000 Gannet eggs or chicks to gull predation. Another incident at the same location caused young auks, mostly Guillemots, to panic and fall from their ledges, resulting in the death of at least 123 birds. A similar panic response has been recorded for species of heron where, because of flimsy nest construction and vulnerable locations, rapid flights from the nest can result in the loss of eggs or young (reviewed in Bell 1972).

More subtle effects were suggested by Burger (1981) in a study of Herring Gulls nesting near Kennedy International Airport. These birds had a lower mean clutch size than expected and it was proposed that this was an indirect result of aircraft disturbance. Significantly more gulls flew up and engaged in more fights when aircraft flew overhead than under normal conditions and it was observed that eggs were broken during these fights. Under normal conditions fights between gulls do not occur because adults return to their nests at different times. However, the aircraft disturbance synchronized the landings of close nesting pairs thus increasing the likelihood of territorial disputes. Chick mortality as a result of aircraft disturbance is also cited by Grubb & Bowerman (1997) where the death of a nestling Bald Eagle was attributed to frequent helicopter flights less than 30 m from the nest which significantly reduced prey deliveries by the adults.

Birds are particularly sensitive to disturbance early in the breeding season. For example, Palmer (1976) and Myerriecks (1960) discuss the sensitivity of Great Blue Herons to startle effects during the early stages of courtship and nesting. Similarly, in a review by Vana-Miller (1987), sporadic activity following the initiation of nesting has been found to have severe effects on Osprey reproduction.

Physiological changes

There has been much experimental work on the effect of noise on the physiology of animals, both wild and domestic (Bell 1972, Fletcher 1988). For example, research on heart-beat rates of breeding Adélie Penguins has shown that rates increase as helicopters fly in the vicinity of their colonies, even when birds remained on their nest and showed no other signs of stress (Culik 1990). This work suggests that unusually loud noises can result in physiological changes that can be equated with increased stress. It has been speculated that continual exposure to disturbance of this nature, although having little visible effect, may reduce reproductive success. A similar effect has been suggested for Black Brant geese in Alaska where stress from aircraft over-flights might inhibit their ability to complete their moult while maintaining or acquiring the body condition necessary for migration (Taylor 1993).

Habitat loss

Frequent and high levels of disturbance can effectively result in habitat loss. This may be in the form of decreased carrying capacity where an area becomes less used by birds or, at its most extreme, it can occur when birds move away from a disturbed site permanently. An example of the latter is cited by Grubb & Bowerman (1997) where aircraft disturbance caused Bald Eagles to depart an area entirely. Consequently, displaced birds may have to feed at higher densities elsewhere, which may effect food intake due to increased competitive interactions between birds.

Mitigation of aircraft disturbance

Any attempt to reduce the effects of aircraft disturbance, for example by setting tolerance distances or disturbance-free zones, is complicated by the large variation in vulnerability to disturbance. This variability occurs across species and within species, across habitat types and between sites, and where exposure to disturbance causes varying amounts of habituation or facilitation. However, there are certain general principles which may help reduce disturbance in most circumstances. Also, a small number of case histories exist that may provide useful examples of effective mitigation measures under certain circumstances.

Timing

The potentially damaging effects of disturbance are greater for birds at particular times of the year. For example, disturbance is most likely to result in greater mortality of wintering birds in conditions of severe weather when food intake rates are reduced and fat and energy reserves are low. As illustrated above, birds are also very vulnerable to disturbance during the breeding season. Thus if aircraft disturbance can be removed or reduced at these critical times then overall impacts may be greatly reduced. Birds are also more vulnerable to 'unusual' disturbance events, for example unfamiliar aircraft types or unpredictable flight behaviour, and these should be avoided at critical times of the year.

Aircraft type

Certain types of aircraft create more disturbance than others. The existing research suggests that the use of helicopters in particular should be avoided in areas of importance for birds. There is also some evidence that ultra-lights are especially disturbing.

Flight distance, altitude and frequency

In some circumstances the use of zones around sensitive bird areas to restrict aircraft movements may be appropriate. Both lateral and altitudinal restrictions may be beneficial, although distances will vary with species and site. For example management plans for Bald Eagles in North America typically include restrictive buffer zones limiting human activity around nest sites and other key habitat areas such as foraging sites. Grubb & Bowerman (1997) suggest that aircraft would best be excluded from within 600 m of nest sites and key habitat areas during the breeding season. Work by Visser (1986) suggests that an exclusion zone of 1000 m may be required to prevent disturbance of roosting waders and Owens (1977) reports disturbance of Brent Geese up to 1.5 km distance. Turning to altitudinal restrictions, the results of the studies of Snow Geese in Québec and Brent Geese in Essex suggested that flights below 500 m over sanctuaries should be prohibited (Bélanger & Bedard 1990, Owens 1977). The work on Black Brant geese by Ward *et al* (1994) indicates that a flying altitude of at least 610 m is necessary to minimise disturbance. The simulation of helicopter disturbance of Black Brant geese by Miller (1994) predicted that the impact of helicopters could be greatly reduced by flying over 1065 m, minimizing flight frequency and by avoiding the use of larger (and thus noisier) helicopter. Similarly, in relation to flight frequency, Bélanger & Bedard (1990) recommended that human disturbance, particularly aircraft over-flights, should be reduced to less than one event per hour.

No-fly zones

There are two mechanisms for identifying such no-fly zones in the UK. The Civil Aviation Authority (CAA) publishes information on 'Bird Sanctuaries' and the MoD identifies national 'Avoidance Areas'. Both rely on map-based information to warn pilots of the location of large numbers of birds in order to reduce the risk of bird strike. The CAA defines a Bird Sanctuary as an *airspace of defined dimensions within which large colonies of birds are known to breed*. The location of these sanctuaries are listed in the UK Aeronautical Information Publication (AIP), an important reference for all civil pilots, giving details of location, avoidance distances (up to 3 nm) and heights (up to 4000 ft). Pilots are requested to avoid the Bird Sanctuaries during a particular period or during the breeding season. They are also advised to avoid flying at less than 1500 ft above surface level over areas where birds are likely to concentrate, such as offshore islands, headlands, cliffs, inland waters and shallow estuaries. The AIP recognizes that, apart from the danger to flying aircraft, the practice of flying close to breeding birds should be avoided for conservation reasons. However, these warning are only advisory for civil pilots.

The MoD can designate permanent and seasonal Low Flying Avoidance Areas to restrict the use of low-flying military aircraft. These are part of the UK Low Flying System (UKFLS) which aims to spread low-flying activity as widely as possible in order to reduce the burden of disturbance in any one area. Military aircraft are deemed to be low-flying when, in the case of fixed wing aircraft, they are less than 2000 ft above the surface, and for propeller-driven light aircraft and helicopters, when they are less than 500 ft. Avoidance areas include civil airspace around airports, airfields and glider sites, industrial sites, major built-up areas, stud farms and hospitals. Some bird reserves and sanctuaries are also included, although the list is far from comprehensive and requires a review.

Reducing other sources of disturbance

Finally, in circumstances where it is not possible to reduce or eliminate aircraft disturbance, it may be beneficial to reduce other sources of disturbance present on the site. This requires an integrated approach to controlling disturbing activities such as wildfowling, sailing and public access through temporal and spatial zoning. For example, the designation of refuges from wildfowling disturbance may help reduce the effects of facilitation and thus lessen the impacts of aircraft activity.

Conclusion

As with all forms of disturbance, it is often difficult to identify the effects of aircraft on birds, especially at the lower levels of potentially disturbing activities. Detecting effects is further complicated by the great variation in response of birds to aircraft, depending on a whole range of factors including aircraft type, proximity and frequency of flights and noise levels. Add to this variation the additional factors of flock size, habituation and facilitation, and it quickly becomes apparent that simple generalisations regarding the effects of aircraft cannot be made. This is especially so when consideration is given to the host of other variables that influence bird populations, including food availability, habitat change, competition, predation and weather. However, from the current information on aircraft disturbance the following general points can be made:

- Low-flying helicopters and ultra-lights cause the greatest level of disturbance.

- Low flight altitudes cause most disturbance; flights over sensitive bird areas should be at least 500 m above surface levels, and preferably over 1000 m (especially for helicopters).

- Unpredictable, curving flight lines are more disturbing than predictable, straight flight lines; birds can often habituate to regular and predictable events.

- The impact of aircraft disturbance may be increased if other sources of disturbance effect the same area.

- Cliff-nesting and other colonial seabirds during the breeding season and flocks of waterfowl during the winter are most vulnerable, especially during severe weather conditions.

- No-fly zones should be sought if serious disturbance is apparent.

Any future studies of the effects of aircraft disturbance, as with all forms of potentially disturbing activity, should take into account a range of factors: the intensity, duration and frequency of disturbance; proximity of source; seasonal variation in sensitivity of affected species; whether birds move away and return after disturbance ceases; whether there are alternative habitats nearby; and whether there are additional forms of disturbance. Ideally work on disturbance effects should include before-and-after studies and experimental controls. However, the flexibility for before-and-after studies rarely exists and often the disturbance is established and on-going. In these circumstances several sites should be studied and as many variables as possible should be measured in order to identify reliable correlations between bird activity and disturbance.

Once an effect has been identified, it is rarely possible to establish an impact on population dynamics and survival without extensive research into the behavioural responses of individual birds. As research of this nature requires significant time and resources it is not always practicable. Where time or resources are constraining it will be necessary to rely on existing research results as presented here to indicate *potential* impacts. Thus, for examples of higher levels of disturbance where an effect has been established, the existing research literature that identifies impacts on populations should be used to reinforce the precautionary approach. However, the evidence for impacts at the lower levels of disturbance is less strong and this requires further research.

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Produced by Allan Drewitt, Birds Unit, 2 August 1999