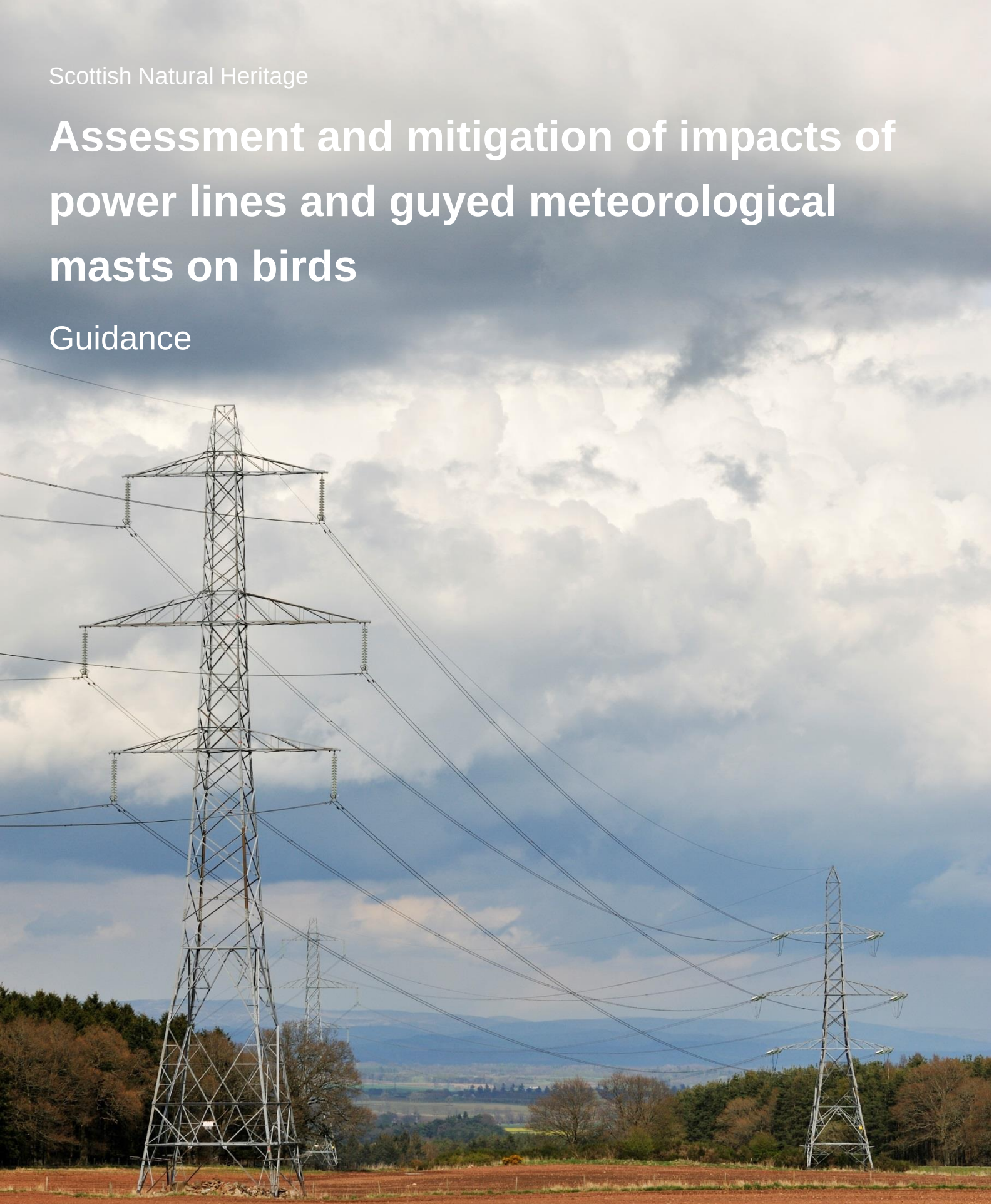
Scottish Natural Heritage

Assessment and mitigation of impacts of power lines and guyed meteorological masts on birds

Guidance



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1. PURPOSE

This guidance document provides advice on how to assess the potential impacts on birds of proposed overhead power lines. It includes advice on mitigating risk of collisions both with power lines and with guyed meteorological masts. The target audience for this document includes developers and their ecological consultants, SNH staff and those within the consenting authorities.

This guidance focuses on high-voltage transmission lines which normally transmit electricity over large distances between load centres; e.g. for Scottish Hydro Electric Transmission these are defined as lines carrying 1500V and above. They usually require an assessment for consent under section 37 of the Electricity Act and therefore require significant survey work to inform Environmental Impact Assessments. However, low-voltage distribution power lines (smaller structures carrying power to domestic end-users) can also have significant impacts on birds and much of the text may also be relevant to these, especially with regard to mitigation. Meteorological masts are also considered, as their supporting guy wires can present a collision risk.

2. POTENTIAL IMPACTS ON BIRDS

It has long been known that overhead wires associated with power lines (and other man-made structures) present a hazard to birds. There are three main risks:

- Mortality through collision with power lines, or the guy wires supporting meteorological masts. This can occur when a bird flies into a wire and is killed either from the impact, from hitting the ground, or from injuries sustained in the process. On power lines, bird collisions are often concentrated along relatively short sections where several factors interact to create a collision problem or 'hotspot'. The combining factors that create a hotspot may not always be apparent.
- Mortality through electrocution from power lines or supporting structures. Birds that perch or nest on steel lattice towers (commonly referred to as pylons) can be electrocuted by causing a short circuit, either by touching two live wires, or a live and an earthed component. However, with most transmission pylons the air gaps between live components are too large to be bridged by birds commonly found in Scotland, so electrocution is more frequently associated with distribution power lines where air gaps are smaller.
- Displacement, where birds are excluded from areas that were suitable for them before the development. This can be caused by a number of factors, including direct loss of habitat to accommodate the infrastructure (such as felling woodland to create a wayleave), indirect loss of habitat if birds avoid the structure and the surrounding area due to its presence, an increased predation risk if pylons are used as perches by predators and/or disturbance through construction and maintenance activities. Displacement can also include barrier effects in which birds are deterred from using their normal routes to feeding or roosting grounds.

While there is a lack of data from the UK on the effects of power lines on birds, research globally has shown that bird interactions with overhead lines are almost all negative (see Lehman *et al*., 2007; Drewitt & Langston, 2008; APLIC, 2012). A possible exception to this is

the use of pylons for perching and nesting by some species, e.g. corvids and raptors, although this can also put them at greater risk of collision or electrocution, and can impact other species (e.g. ground-nesting birds) if they are then increasingly taken as prey.

A range of factors influence the risk of bird mortality:

- Species-specific morphology and biology; birds with larger body sizes and high wing loadings, birds flying in flocks and/or in low light, birds with limited visual capacity, birds distracted while engaged in hunting/breeding behaviours, younger and more inexperienced birds and migrants not familiar with the landscape may all be at increased collision risk. For example, swans and other large waterfowl are of particular concern for collisions in the UK (Taylor *et al.,* 2015).
- Landscape and topography, e.g. siting power lines near or crossing important areas or flyways used by birds may increase collision risk.
- Weather, e.g. strong winds, fog, or heavy rain may force birds to lower their normal flight heights, affect flight control and reduce visibility and therefore reduce ability to avoid collisions.
- Technical aspects, e.g. spacing of conductors (the current-carrying wires) and the availability of perches affect electrocution risk. Earth wires (sometimes called the static or ground wires, which protect the power line from lightning strikes) are thought to be responsible for a much higher rate of collisions than the thicker, often bundled conductor wires. This is because they are harder for birds to see and are typically positioned at the top of the wire array, putting them in the flight path of birds which have taken avoiding action to fly over the conductors.

International research shows that compared with collision and electrocution, the effects of disturbance and displacement of birds at power line developments are much more poorly known. However, in Scotland, there is little empirical evidence with which to understand any of the potential effects.

3. PRE-SURVEY CONSIDERATIONS FOR POWER LINE ROUTING

Careful routeing is critical to minimise the impact of a power line on birds, and wherever possible should:

- Avoid protected areas designated for their bird interest, including Special Protection Areas (SPAs), Sites of Special Scientific Interest (SSSIs) and Ramsar sites.
- Avoid areas outside protected areas that are used by birds which are a qualifying interest of a connected protected area.
- Avoid known roosting and feeding areas, any known flight paths between these areas or any known flight paths used by migrating birds. For example, placing a power line between fields used by grazing geese and a roost loch could cause mortality of commuting birds colliding with the wires or potentially create a barrier effect leading to reduced use of the site.
- Take into account topographical features affecting general bird movements, e.g. valleys that may be used as flight paths. Running power lines along existing linear elements of equal or greater height (e.g. cliffs or rows of trees) may reduce collision

risk as birds will react earlier to fly over the more obvious obstacle. Grouping linear obstacles (e.g. other power lines, treelines, roads) may also lower overall impacts.

4. SURVEY WORK

Once the preferred route has been chosen for a transmission power line, field surveys will be required to provide up-to-date information on bird distribution and activity, to assess the risk to birds and to inform any required mitigation.

4.1 Survey period

Power companies in Scotland currently consult extensively and iteratively in order to identify economically and technically feasible routes for transmission lines which minimise impacts on the environment, landscape and local communities. Given this, we consider that **one year** of relevant bird survey work is appropriate for proposed transmission power line developments. The potential risk to birds varies with the size and location of the proposed line, but when survey duration of less than one year is proposed, developers and consultants must clearly demonstrate that the chosen duration is robust and appropriate to the specific proposal.

Additional survey work after one year may be required in some cases and on some sections of the proposed line, for example:

- To enable further detailed assessment of impacts of birds on, or connected to, protected areas.
- In areas where bird sensitivity is expected or has been shown to be high, especially where activity varies significantly between years.
- Where land use changes during survey work may have implications for the use birds make of the landscape and, therefore, the representativeness of survey results (e.g. plantation felling, flooding at the time of survey).

4.2 Survey methods

The principles and methods of surveys required for assessing a power line development are broadly similar to those set out in the SNH Bird Survey Guidance for Onshore Wind Farms. Advice on selecting target species is also relevant; species susceptible to wire impacts include waterfowl, waders, raptors and game birds, with passerines not normally of concern. Data should be recorded and presented as described (apart from the requirement for collision risk modelling (see Section 5), although the presentation of VP data should still include bird activity flight line maps at power line collision risk height to allow a qualitative assessment of risk). The Bird Survey Guidance for Onshore Wind Farms should therefore be used to plan an appropriate suite of surveys. Other published SNH guidance that may also be useful in planning survey work is:

- Significance of impacts on birds outwith designated areas
- Assessing the cumulative impact of onshore wind farm developments
- Guidance on assessing connectivity with Special Protection Areas (SPAs)

With general information already available, this guidance addresses only survey and assessment specific to power lines which is not covered elsewhere.

For meteorological masts, bird survey work conducted to inform the associated wind farm proposal should enable developers to form a view of the bird populations on, or in proximity to, a site. Additional survey to inform mitigation of masts is not generally required.

4.2.1 New vs. replacement power lines

Replacing an existing power line is usually preferable to building on a new site, because the general area is already disturbed. In addition, it may provide the opportunity to improve an existing power line configuration to make it safer for birds. The required duration and scale of survey work will usually be the same for replacement as for new lines because:

- Replacement power lines won't normally be on exactly the same route as the existing line, especially as the old line may remain operational until the new line is built, so new wayleaves will usually be required.
- Replacement power lines are likely to use different sized structures and/or different wire configurations to the old line, which presents a different risk to birds.
- While it may be that the original line was sited appropriately to minimise bird impacts, it cannot be assumed that it was having no negative impact. Survey work will help to assess 'baseline' impacts and potentially identify problems that can be mitigated with the replacement.
- Old power lines are likely to have been in place for some time, over which the ecological conditions of the site may have changed, resulting in different habitats and bird activity.
- Disturbance during construction may last longer than for new lines because the old line will also need to be removed. However, this is not always the case as dismantling can be undertaken in parallel with other activities, with the timing of works dependent on the specific construction programme.

4.2.2 Area of survey for power lines

When a suitable suite of surveys has been determined, the area over which to conduct the surveys must be decided to ensure the bird interest of the site is adequately characterised and the potential impacts of the development properly assessed. This area should cover the whole development (including ancillary structures and works, e.g. access tracks), and extend a suitable distance beyond it to take account of potential impacts on birds close to the development. For generic distribution and abundance surveys (e.g. moorland breeding birds, feeding waterfowl), we suggest that habitat is used as the basis for width determination of the key area of interest along the corridor (Table 1). However, many species of interest (e.g. raptors) are more wide-ranging, and so a wider survey corridor will usually be required for species-specific survey; details on these widths are given in Table 1.6 of the Bird Survey Guidance for Onshore Wind Farms. For example, for black grouse a survey width of 1.5 km either side of the proposed route would be appropriate.

Depending on the scale of the development, it may not be necessary to undertake vantage point (VP) watches along the whole length of the route corridor. VP observations should focus on sensitive sites and areas used by target species. In addition, data from other

sources (e.g. Scottish Raptor Study Groups) may limit the need for distribution surveys of wide-ranging birds.

Table 1. Recommended corridor widths for generic distribution and abundance surveys around the power line route, or limits of deviation where the exact route is undecided.

Habitat/feature	Width (either side of proposed route)
Crosses or has connectivity with a protected area with bird qualifying features	At least 500m depending on qualifying feature
Wetland habitats, rough grazing and moorland	500m
Woodland or urban/developed sites	125m
Other habitats	250m

5. COLLISION RISK MODELLING

There is currently very little empirical evidence on bird interactions with power lines in Scotland or elsewhere in the UK. Whilst the collation of data on recorded impacts can help to develop our understanding of this, there is currently no statistical model available which we are confident would provide a robust assessment of potential mortality. Collisions are usually site-, season- and species-specific, and a generic collision risk model is unlikely to accurately predict levels of mortality. We do not, therefore, currently recommend a generic modelling approach.

In recognition of the difficulty this presents we recommend that emphasis is put on mitigation where surveys indicate potential conflicts. In cases where impacts are likely to be severe, and mitigation may not reduce this sufficiently, bespoke models may be useful if they are based on the best available information from the site and on the attributes and status of the species of concern. An example of this may be where there is a level of flight activity at the proposed line which is high enough to raise concerns about potential collision mortality impacts at a designated site or regional population scale.

6. MITIGATION

Various mitigation measures may help to reduce the impacts of wires on birds. For power lines, these include:

- Route planning to avoid areas of high bird use.
- Using bird-friendly power line designs. This is the most effective way of preventing electrocution on distribution lines; good designs protect birds by deterring perching and nesting, and by using insulated components and/or large air gaps. Configurations with fewer layers of cables vertically, and without an earth wire, may also reduce collisions.
- Installing cables underground. Whilst the only way to completely eliminate collision mortality, it is a costly option that is likely only to be necessary where the significance of the impact justifies the additional costs.

- Installing line markers on earth wires and/or conductors as appropriate to reduce collision.
- Carrying out construction and maintenance activities outside of the breeding season (or otherwise siting the line beyond disturbance distances of sensitive species present in the area, as detailed in Ruddock & Whitfield (2007)).

For meteorological masts, mitigation measures include:

- Siting the mast in a location with a low collision risk.
- Installing line markers on guy wires.
- Using non-guyed masts (although if using lattice towers, developers should be aware of the potential nest/perching site opportunities these present and site them appropriately).
- Carrying out construction and maintenance activities outside of the breeding season (or otherwise siting the mast beyond disturbance distances of sensitive species present in the area, as detailed in Ruddock & Whitfield (2007)).

6.1 Line marking

Installing power lines underground and avoiding the use of guyed masts should be considered first where significant collision impacts are predicted. However, recognising that this is not always feasible, consideration should then be given to marking lines. Line marking remains the most common and practical form of wire collision mitigation worldwide, and research shows that it can reduce bird collisions for some species by 50-94% (evidence reviewed in Prinsen *et al*., 2011). In the UK, there is evidence that marking is effective in reducing wildfowl mortality, particularly for swans (Frost, 2008). However, there are limitations; the efficacy of line marking varies considerably between species and regions and is very unlikely to eliminate mortality entirely (especially for crepuscular or nocturnal species).

Several factors influence the efficacy of markers, including the morphology, behaviour and visual capacity of the species at risk, the overall visual effect of the markers against the background landscape and engineering factors such as marker durability and the structural integrity of the power line/mast. There is unlikely to be one type of marker that is suitable for all species and circumstances. However, in general we advise that wires are marked with devices that are as large as possible and, on power lines, installed from pylon to pylon. Spacing often depends on technical considerations, but markers should be installed as close together as possible (at least every 5-10 m on power lines), and in contrasting colours e.g. black and white for maximum visibility in different weather and light conditions (Prinsen *et al*., 2011). Line markers will also need maintenance and replacement; ensuring that markers remain in position and functional throughout the lifetime of the power line/mast is essential. Research in this field continues (e.g. the development of nocturnal devices), so the most up-to-date information available on marker effectiveness and design should be used.

6.1.1 When to install line markers

Survey work for power lines should provide good information on use of the landscape by birds known or likely to be susceptible to collision. Decisions on where to place markers should be informed by this. For susceptible birds, line sections which are routed through

protected areas designated for the species, areas of substantial flight activity and/or those close to roost, breeding or main feeding areas should be considered for marking. What level of flight activity constitutes 'substantial' and how far from key areas marking needs to continue will depend on the species, site and the risk posed by development involved. This judgement should take into account the core foraging areas of the affected species, connectivity distances, susceptibility to collision, status of the population(s) and the potential population significance of collision mortality.

The decision on whether to mark meteorological masts should be more straightforward. Masts should normally be marked at and up to 2 km away (depending on the range of the bird concerned) from sites protected for or containing roost, breeding and foraging areas of collision susceptible species.

7. INFORMATION PRIORITIES

There is currently a paucity of data on power line impacts in Scotland and elsewhere within the UK. Information that would help to address knowledge gaps includes:

- Species-specific flight avoidance rates for standard power line configurations. VP surveys of existing power lines would contribute useful information to estimate these.
- Information on collision events of susceptible species (particularly waders and waterfowl) obtained through regular mortality searches of representative sections of existing power lines. If relevant experiments are also conducted to quantify survey biases (e.g. the proportion of carcasses lost to scavengers, the proportion not found by searchers), these can help to quantify collision rates.
- Assessments of the effectiveness of power line markers in reducing collisions of susceptible species.

It would be helpful if developers working on sites with a likelihood of impact could make available relevant data sets that will help to refine our understanding of the above.

8. ACKNOWLEDGEMENTS

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9. CONTACT

If you have any comments or queries about this guidance, please contact Dr Jessica Shaw at the SNH office at Battleby, Redgorton, Perth, PH1 3EW, or email jessica.shaw@snh.gov.uk.

10. REFERENCES

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