Guidance

SCOTTISH NATURAL HERITAGE

SURVEY METHODS FOR USE IN ASSESSING THE IMPACTS OF ONSHORE WINDFARMS ON BIRD COMMUNITIES

November 2005

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1 Purpose

1. SNH and the BWEA have prepared draft guidance (Scottish Natural Heritage 2000a, b) on assessing the impacts of a wind farm on ornithological interests, which outlines the three potential risks which wind farms present to birds:

   (i) displacement through indirect loss of habitat if birds avoid the wind farm area and its surrounding area due to turbine operation and maintenance/ visitor disturbance. Displacement can include barrier effects in which birds are deterred from using normal routes to feeing or roosting grounds;

   (ii) death through collision or interaction with turbine blades;

   (iii) direct habitat loss through construction of wind farm infrastructure.

   An assessment of a potential wind farm's effect on the bird interest of a site should thoroughly consider each of these three potential risks for each bird species which uses the site.

2. **For each of these three risks, knowledge of bird distribution and activity is necessary in order to quantify the risk. The purpose of this guidance is to advise on the field survey methods which should be used to enable these risks to be assessed.**

3. This guidance is written for developers and their ecological consultants, and also for SNH Area staff and those within the consenting authorities who are required to consider documents relating to ornithology submitted as part of a wind farm application.

2 Background

4. Despite Europe now being the world leader in the development and installation of wind farms (European Wind Energy Association 1999) it lags well behind the USA in the development of standard methodological protocols and guidelines

for the assessment of wind energy-bird interactions. Thorough background guidelines and general principles to be followed when studying wind energy – bird interactions have been produced in a lengthy report (Anderson et al. 1999), but were written with the USA development planning procedures in mind. More detailed guidance on appropriate methods have also been produced (e.g. Gauthreaux 1996), but these also have a bias towards the USA. Of course, many scientific methods are equally valid wherever they are practised in the world, but the large volume of work produced in the USA has not been incorporated in to European guidance at the same level of detail. Best practice guidance documents for Europe (European Wind Energy Association undated, 1999) and the UK (British Wind Energy Association 1994) contain little specific information to guide developers or other stakeholders on methods that should be employed.

5. The SNH/ BWEA guidance (Scottish Natural Heritage 2000a) on assessing the effects of wind farms on ornithological interests is helpful, and is supported by specific guidance on the assessment of collision risks (Scottish Natural Heritage 2000b). However, it lacks detail in areas such as bird survey methodologies and monitoring protocols. The present document is designed to address survey methodologies and hence replaces the previous SNH guidance on survey methods (Scottish Natural Heritage 2002). Monitoring protocols will be addressed in separate guidance.

6. The use of standardised methods of bird impact assessment will help to maintain consistency across assessments, facilitate comparisons between sites and assist in the prediction of effects at future developments. Nevertheless, each site, and the likely impacts of a wind energy development on each site, is different. As a result, it is not possible to provide 'cookbook' guidance with a simple recipe for any particular case. Hence, the present guidance is advisory only. It is intended to chart out the principles which should inform the development of a well-designed assessment that is appropriate in method and effort to the circumstances of the site. Departure from these principles and methods does not necessarily mean that survey methods are deficient. Developers should make clear where variations have been adopted and the justification for using such variations.

3 Guiding principles

3.1 Matching field survey to the information needs

7. The key question to be addressed by the Environmental Impact Assessment (EIA) process is whether the development is acceptable in terms of the likely significant effects identified. The aim of a bird field survey is to provide the information which will be sufficient to enable an assessment of the impacts arising from habitat loss, displacement, and collision risk. A bird survey on its own is not an assessment of impact. Essentially a field survey can provide information on :

- the type and number of birds that may be displaced, and the extent and importance to bird populations of the area from which they may be displaced (whether through disturbance or habitat loss);

- levels of flight activity and types of flight behaviour, which can be used in assessing collision risks.

8. The EIA will have to combine that knowledge of birds with an understanding of the expected interactions between these species and wind farms, and with an understanding of the status and sensitivity of the bird populations, to draw conclusions as to whether these impacts are significant or not. These judgements will depend on the species present, whether a site designated for bird interests is involved, and the scale of the proposal itself and its impacts. Where there are already existing wind farms in the locality, or others proposed, then it may be necessary to consider the potential cumulative effect of the proposed wind farm in combination with these others[1].

9. It follows that there is no requirement for a set threshold of survey effort to be reached or exceeded. Survey requirements should flow from a clear view as to what knowledge is needed for the purpose of assessment. Different sites may require a different suite of methods.

3.2 Target species

10. Effort in assessing impacts, and hence the target bird species for field survey, should be focussed on those species for which there is potential for an impact which might be judged significant and adverse. In most circumstances the target species should be limited to those protected species and other species of conservation concern which, as a result of their flight patterns or response behaviour, are likely to be subject to impact from wind farms.

11. There are three important overarching species lists which describe protected species and species of conservation concern :

    Annex 1 of the EC Birds Directive
    Schedule 1 of the Wildlife & Countryside Act 1981
    Red-listed Birds of Conservation Concern[2]

    In addition, special consideration should also be given to species identified locally as of conservation concern within Local Biodiversity Action Plans, and any other species for which the site hosts a particular concentration.

12. Within these lists, the greatest attention should be paid to those species most likely to be subject to impact from wind farms. Raptors are considered to be particularly vulnerable to collision risk (NWCC 2000), and any species that is not manoeuvrable in flight (e.g. species that are adapted for soaring) may also be vulnerable. On the other hand, 'Red-listed' passerines breeding in the

[1] see SNH guidance 'Cumulative effects of wind farms', SNH website www.snh.org.uk (2004)
[2] These may be found on the JNCC website at www.jncc.gov.uk/pdf/pop_status_of_birds_card.pdf

uplands are not currently thought to present a concern with respect to wind farms, and so need not be given special consideration in the uplands. Birdlife International (Convention on the Conservation of European Wildlife and Natural Habitats 2003), presents a table which indicates the collision risk sensitivity of different species groups to wind turbines. The authors emphasise that there is a general lack of impact studies upon which to base such a table, and that the list is therefore indicative rather than comprehensive. There is a particular dearth of good impact studies for those habitats typically used for wind farms in Scotland.

13. Local circumstances may indicate that survey information should also be acquired about other species, especially those of regional conservation concern, and such species are termed *secondary species.* Recording of secondary species (see Appendix 1) is subsidiary to recording of *target species.* The list of any *secondary species* should be determined at scoping stage.

3.3 Designated sites

14. Where a site is designated for its bird interest, either as an SSSI or as a Special Protection Area as required by the European Birds Directive, the requirement that a wind farm proposal should not adversely affect those interests becomes more explicit in legislation or planning guidance. The protection requirements following from European Directives for Natura sites, embodied within the UK Conservation (Natural Habitats &c) regulations 1994, place a stringent requirement that, normally, before a development proposal is approved, it should be ascertained that proposals will not adversely affect the integrity of a Natura site; exceptions may only be made where there are imperative reasons of overriding public interest. Scottish Executive national planning guidance (NPPG 6 revised) states that wind farms should not adversely affect the interest for which an SSSI is designated.

15. While neither the legislation nor planning guidance preclude wind farm development in or near an SPA or SSSI designated for bird interests, it follows that a greater effort in detailed study is required to demonstrate whether a proposal is acceptable or not, so development costs are greater. There is also a higher chance that a planning application will be refused, so development costs are less likely to be recouped. Hence, it is clearly beneficial to all stakeholders that an early identification of whether a site is important for birds or not should be part of the site selection process. This may be considered as the very earliest stage of assessment, and ideally occurs before the formal Environmental Impact Assessment process is entered.

16. Natura sites are accorded the highest sensitivity to wind farm development in SNH's strategic locational guidance for onshore wind farms, and all areas with several bird species of conservation importance likely to be sensitive to wind farm development are classed as of medium sensitivity.

17. The European Wind Energy Association recommends that wind farms should not be located in areas important for birds, such as Special Protection Areas

(SPAs) or Ramsar sites (European Wind Energy Association 1999). The Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats 2003) has also echoed the need to avoid areas which are important for birds (page 6):

"There is a strong consensus that location is critically important to avoid deleterious impacts of wind farms on birds. There should be precautionary avoidance of locating wind farms in statutorily designated or qualifying international (e.g. Natura sites – SPAs and SACs) or national sites for nature conservation, or other areas with large concentrations of birds, such as migration crossing points, or species identified as being of conservation concern. The favourable conservation status of habitats and species in these areas is a central tenet to their designation, requiring demonstration of compatibility with this aim by any proposed development. The weight of evidence to date indicates that locations with high bird use, especially by protected species, are not suitable for wind farm development."

18. Note that the protection arrangements for designated sites take account of the fact that developments outwith the site boundary may affect the interest within. Therefore, for proposed wind farm sites which lie outwith but close to the boundary of a site designated for its bird interest, then the bird interest for the designated site should be also included as explicit targets for analysis of bird impacts. The distance over which such effects may be important will be related to the foraging ranges of the species concerned.

3.4 Taking account of scale and sensitivity

19. The potential risk to birds clearly will also vary with the size of the wind farm: a larger wind farm covers a greater area and has more turbines. For many species, collision risk may only be a serious problem if the wind farm is large. Conversely however, small developments e.g. 1- 5 turbines, may also present a potential risk if placed in areas of high bird sensitivity. Analysis of the possible impacts of a proposed scheme on birds, and the effort made to assess impacts, should be in proportion to the scale of the scheme and the bird interest in the area. Appendix 2 provides some discussion and examples of how observation effort can vary. The guiding principle should always be that the aim is to identify and describe any likely significant environmental effects.

3.5 At least one year and preferably more

20. Fieldwork should span all periods when the target bird species are present during at least one full year. All assessments are improved by more than one year's data on bird use of a site. For some species that are strongly traditional in their activities, such as golden eagle, year-to-year variation in use may vary less (unless alternate nest sites are used), but for most other species the use of a site may be variable from one year to the next. Year-round resident species may show seasonal variation in their use of a site and it is necessary for the assessment to account for this. Species and abundance may also vary seasonally or according to breeding status and assessments should account for such variation.

21. A typical assessment will seek to predict what the effect of the wind farm will be over, say, a period of 25 years for which consent for the wind farm is being sought. If the assessment is based on information from 1 year or 2 years only, it is vital that potential changes between years and any underlying trends should be taken into account as an integral component of the assessment. One obvious source of variation in the use of a site by birds is variation in breeding success. The influence which breeding success may have on bird usage of a site is explicitly covered in some sections below on assessment methodology, but this influence is universal and must be taken into account for all bird interests.

3.6 Retain flexibility

22. The assessment process should retain the flexibility to be able to respond to new information, as 'unforeseen' findings may arise, including extending the field survey to ensure there is sufficient information, or in some cases truncating it where there is adequate evidence that target species are so rarely present that a significant impact is unlikely. Inappropriate or inadequate effort in observation of ornithological interests has often arisen because of the difficulties in redesigning surveys to respond to new information.

3.7 Use skilled observers

23. The quality, experience and skills of observers are very important attributes in ensuring good and reliable data are collected. The reliability of the assessment is wholly dependent on the observers used to collect the information on which the assessment is based and so the use of quality fieldworkers is of fundamental importance.

4 Scoping

24. Scoping is a crucial preparatory stage to the preparation of an environmental statement. The aim of scoping is to identify those issues which are potentially of significant environmental impact, and which therefore warrant full assessment within the environmental statement, and if necessary consideration of mitigation measures. A parallel aim is to avoid wasting effort on issues which are unlikely to present a significant environmental impact. Developers are strongly encouraged to liaise with SNH at an initial stage to help establish the scope, and to follow-up with a formal scoping request prior to preparation of the environmental statement.[3] For bird impacts, there are often major areas of uncertainty at scoping stage, and the purpose of further survey and assessment

[3] See SNH's Renewable Energy Service Level Statement, available on SNH's Website www.snh.org.uk

will usually be to resolve these uncertainties and to establish whether or not the effects will be significant.

25. Developers should combine three approaches towards forming a view on the bird populations on a site and their likely sensitivity:

    - Desk-based study of existing information.
    - Appraisal of habitats and species likely to be present.
    - Reconnaissance survey.

    The objective of all three approaches is to provide a picture of the level of bird interest on the site, in order to inform the scale and type of observation and survey effort which will be necessary to conduct an adequate assessment of those impacts likely to be of significant environmental effect. These approaches are discussed in more detail below.

26. Thereafter it is recommended that developers should prepare a scoping report. The scoping report should present the results of this analysis, draw conclusions about which species may have the potential to suffer significant impact as a result of habitat loss, displacement, or collision risk, and make proposals for a survey programme which would enable the impact to be better quantified. Since the scoping report provides justification for the proposed assessment survey methodology, full details of the methods and results of all pre-scoping desk- and field-based exercises should be included. The scoping report should also contain as much detail as possible on the proposed survey methodologies and how and why they are to be used. Where possible it should also indicate any impacts which it is proposed should be addressed by mitigation.

27. If the three types of analysis above indicate clearly that there are no target species on the site (noting the caveats concerning the possibility of change in bird distributions and not equating a lack of information or inadequate information with a lack of bird interest) then there should be no need for further detailed survey. For example, for a small wind farm proposal of, say, up to three turbines in a habitat or location known not to contain species of conservation interest, then detailed survey may not be necessary.

28. The value of reconnaissance surveys and collation of existing ornithological information for the site can not be over-emphasised as a means of reaching a view, expressed at scoping, of the knowledge required to reach an objective judgement on the proposal's acceptability. Clearly, when more information is available pre-scoping then the survey requirements outlined at scoping will be more likely to be appropriately gauged.

4.1 Desk-based analysis and habitat appraisal

29. A well-planned assessment should first conduct a desk-based study of existing information. It is recommended that developers liaise with SNH and other bodies such as RSPB at an early stage, with a view to gathering a preliminary

view of likely bird sensitivities on the proposed site. Bird survey data may exist for the site in previous years and may be held by SNH, RSPB, BTO, Scottish Raptor Study Groups (SRSGs) or local bird recorders (note that these data may come with confidentiality and ownership restrictions regarding their use and circulation, which must be respected). Proximity to designated site(s) can also provide an indication of the likelihood that the species for which the site is designated may use the proposed wind farm area even when the proposed wind farm is at some distance from the designated site e.g. if the proposal area intercepts a potential route used by geese flying between roost and feeding sites.

30. The habitat of the site can also provide indications of the bird species likely to be present. Land cover data, habitat survey or site visit(s) by ornithologists familiar with bird-habitat associations can therefore be useful.

4.2 Reconnaissance survey

31. Although existing bird survey data are invaluable, these are no substitute for the collection of novel data contemporaneous with the proposal, as bird distributions can change. For many areas there may often be no existing data on the bird interest, especially for some seasons (e.g. winter or migration). The absence of any data does NOT indicate that there is no interest which needs to be assessed; rather the absence of existing data heightens the need for novel information. To supplement or improve the knowledge base at scoping, 'full' or 'scaled down' versions of standard survey and observation methods should be employed as a 'reconnaissance survey'. Only in exceptional cases, where reliable and recent sources of other information are available, will reconnaissance survey be unnecessary.

32. 'Walkover' methods can be used to provide an idea of the bird interest of a site since they are designed to record bird activity over large areas of ground relatively quickly. **They should not be used as a substitute for more formally constructed survey methods or VP watches which are warranted when target species are known to occur**. In this respect, their main value is in reconnaissance. Bird interests detected during walkover surveys may lead to a requirement for more detailed survey and VP watch effort. For open upland areas in winter, the method can be useful in describing the bird community which may be present, although if species of conservation interest are present (e.g. some species of raptor) then VP watch effort will generally require being increased (see section 3 and Appendix 2). In winter, too, bird distributions may vary substantially from day to day and week to week.

33. Essentially a walkover method combines the use of shortened (e.g. 1 hour) VP watches (Appendix 1) with a walk route between VP locations designed to maximise coverage of the study site and approach to landscape features which may be of potential ornithological importance e.g. ponds, hedgerows (i.e. in the fashion of a Brown & Shepherd (1993) survey or the survey method for wintering lowland birds – sections 6.2.1 and 6.8.1). Periodic scanning for birds and stops to listen for calls should be part of the walk around the survey area.

Where wintering wildfowl are present or suspected, survey visits once a month can be appropriate in winter, with walk routes and the order of VPs visited varying between visits.

4.3 Flexibility

34. The methodological statements prepared at scoping should therefore include the capability to respond to unforeseen findings. Even if during the scoping phase of assessment there have been no records of use of the site by a particular species, this does not mean that the species is definitely absent. It may simply reflect the absence of relevant survey information. If information on a sensitive species comes to light part-way through the assessment process, it is likely that SNH and the consents authority will wish the impacts on that species to be assessed. Either the consents authority, or SNH as a statutory consultee, can potentially advise that further work may be required at any stage of the planning process. With this in mind, SNH should convey any novel information to the developer or his/her representatives as soon as it becomes available, and encourages RSPB, BTO or any other organisation with relevant data to do likewise.

35. It is recognised that some developers, in the interest of avoiding any delays due to reporting of a reconnaissance stage, may proceed directly to a stage of undertaking comprehensive bird survey. In these circumstances the early stages of that bird survey will take the place of reconnaissance survey. SNH nonetheless encourages such developers to engage in a scoping dialogue, at an appropriate stage following early survey results, in order to ensure there is agreement on the appropriate target species and methodologies for the assessment of impacts.

35. From the outset, there is a need for assessment requirements expressed at scoping to be thorough, comprehensive and flexible in scope, bearing in mind that the onus to conduct a proper assessment rests on the developer.

5 Survey of a reference or control site

36. Wherever the potential risk to a bird species is a critical issue in the determining process – or wherever, despite a best assessment that impacts will not be significant, there remains a significant degree of doubt – SNH recommends that the consents authority should include, as a condition of consent for the proposal, a requirement for post-construction monitoring of the impacts on that species. To take account of both short-term and long-term effects on bird populations, it is recommended that monitoring for displacement effects should be required in years 1,2,3, 5, 10 and 15 of the life of the wind farm and that the results should be collated into two reports, the first 3 years after and the second 15 years after commissioning of the wind farm (consistent with Scottish Executive practice in making S36 wind farm consents). Monitoring for collision mortality may require a different protocol, specific to risks identified during assessment. Such collision monitoring may be related to a requirement for specific actions which would take place in the event that monitoring reveals that

the level of impact is in fact significant – for example a close-down condition during migration periods.

37. The results of many post-construction monitoring studies to date at UK wind farms and in Germany have been hard to interpret because of the influence of fluctuations and trends in bird populations unrelated to the wind farm itself. On occasion this has led to arguments over the conclusions from monitoring. Therefore it is recommended, as a matter of good practice, that monitoring should include a nearby control or reference site, selected on the basis of having a comparable habitat but unaffected by development. Reference sites should not be located too close to a wind farm since any displacement of bird activity from the wind farm may spill in to the reference site, and it is important that reference sites are free from any influence of the wind farm. Reference sites are a key aspect of the standard experimental set up of the BACI (Before-After-Control-Impact) protocol (Anderson et al. 1999). If such a reference site is to be included within post-construction monitoring, then it is also important that it be encompassed within the pre-construction baseline monitoring studies. Monitoring of the reference site, as with monitoring of the site itself, can be highly selective, focussed on the species for which there is outstanding doubt as to the level of impact.

38. Reference sites need not be set up specifically or solely to serve as a reference for one wind farm site. There may be scope for developers to act together to create a series of reference sites where monitoring is regularly undertaken, and the results pooled. SNH and RSPB may also be able to assist in supplying information on recently surveyed sites which may be useful, for example from SNH's ongoing SSSI monitoring programme.

39. Where post-construction monitoring is to be undertaken if the wind farm receives consent, it is important that the baseline survey is designed in such a way that bird distribution, abundance and behaviours before and after construction are readily comparable.

6 Survey and Vantage Point methods

6.1 Types of survey

40. Bird survey methods will vary depending upon the target species to be observed. Careful consideration should be given to selection of the most appropriate methods for the species likely to be present on each site. A range of methods is likely to be needed for each site, dependent on species and habitats present, and guidance should be sought from Gilbert et al (1998) and from SNH as to the most appropriate methods; another useful general reference is Bibby et al (2000). For upland sites, methods such as those described by Brown & Shepherd (1993) for some upland breeding waders give an indication of the numbers of birds which may be affected by a proposed development but are coarse in describing the actual use of a site by individual birds. Vantage Point (VP) watch methodology is of particular use in providing detail of flight activity and behaviour. It can also provide supplementary information on the

extent to which birds may use the site, and therefore any potential displacement effects.

41. The bird survey methods used in assessing wind farm impacts should be tailored according to the bird community present in the locality, the species whose impacts are to be investigated, and the nature of the potential impact (habitat loss, displacement, collision risk). This guidance is not intended to be exhaustive for all species/groups or to repeat full survey methodological details available elsewhere (see Gilbert et al. 1998). However, where bird survey methods differ from those outlined here, the Environmental Statement should set out a clear rationale for using a different approach. Different bird species may require different survey techniques to be undertaken in parallel.

42. Hereafter this guidance is broken down into sections related to specific groups of birds, and each section is divided into two main elements: survey methodology and Vantage Point (VP) methodology. A basic VP watch methods statement is given in Appendix 1; if VP studies vary from this method, developers and consultants should explain within the ES why this has been the case.

6.2 Area of survey

43. The proposed wind farm site should be regarded as the area encompassed within a line drawn around the proposed outermost turbine locations, anemometry masts, substations, cable and grid connections and access roads. Often, at the time of commissioning bird survey, the precise boundary of the wind farm – or even the exact site – is still unknown. In such cases, the proposed wind farm site should include all potential areas which may be included in the final wind farm site, so as to cover all eventualities in terms of final layout.

44. The potential impacts of a wind farm on birds extend beyond the boundaries of the wind farm site. Displacement effects through disturbance of birds at the nest as a result of construction activity, for example, may extend to several hundred metres beyond the wind farm site, dependent on how vulnerable the species is to disturbance. Habitat loss and displacement effects may reduce the available foraging habitat for birds which breed or roost outwith the wind farm. The extent of this impact is the foraging range of the species, which may be several kilometres for owls or raptors, and is typically greater than the distance at which a bird is sensitive to disturbance at the nest. Collision risk may similarly affect birds which only visit the site while foraging or pass through the site en route to roosting or foraging sites. The extent to which field survey is required outwith the wind farm site should therefore be determined according to the impacts which are to be quantified:

- Habitat loss – the need is to know the number of birds within the wind farm site potentially affected by the habitat loss within the site; and

numbers of birds which may nest or roost outwith the site but which are likely to make use of that habitat for foraging.

- Displacement – the need is to know nest sites within displacement range for those species sensitive to disturbance from construction or operational noise or activity; and numbers of birds which may nest or roost outwith the site but which are likely to be displaced from using the wind farm habitat for foraging. Survey distances beyond the wind farm site should therefore be governed by typical foraging or home range distances. Surveys of nest sites provide a surrogate for numbers of breeding birds.
- Collision risk – the need is to have a good representative picture of flight activity and behaviour across all parts of the wind farm site; and to assess the numbers of birds that may use or pass through the site and so which are likely to be subject to collision risk.

45. Thus, while bird survey should extend beyond the wind farm site boundaries, the detail required of the survey differs. Within the wind farm site, there is a need for survey of the numbers and extent of use of the site and if collision risk is an issue, there will be a need for detailed observations of flight activity and behaviour throughout the site. To allow for observer error in locating flight lines, it is sensible to undertake vantage point survey within an envelope slightly larger than the wind farm site, say by 200m in all directions. Outwith the wind farm, the need is a less intensive one: to establish nest sites for sensitive species and numbers of birds which may be affected while using or passing through the wind farm site. 36-hour vantage point surveys as recommended below are not required outwith the wind farm site.

46. The notes for each species group below include more detailed guidance on the distances outwith the wind farm site within which surveys for nesting, roosting or foraging birds should be conducted.

6.3 Duration of survey

47. Where there are target species for which there is a need to know levels of flight activity, so that collision risk can be assessed, flight behaviour should be surveyed over a representative period of time. Vantage point survey involves taking observations from a fixed point at a sufficient distance that the observer can identify species yet not affect bird behaviour. Clearly, the longer the period of vantage point survey, the greater is the sample of flight behaviour and the more reliance can be placed on the data. Conversely, too short a period increases the uncertainty as to whether the level of flight activity observed is truly representative. Collision assessments require assumptions to be made about levels of avoidance, over which as yet there are very high levels of uncertainty; therefore, the level of confidence to be sought in measures of flight activity need not be high; +/- 30% may be entirely adequate.

48. Experience at a range of sites – most often with raptors – suggests that a survey period of 36 hours is a reasonable minimum, and this guidance

document adopts 36 hours as a standard for most species, where vantage point survey is required of an area (eg see Table 2, page 27, for raptors). It is recognised that there may be circumstances where variations from this standard either downwards or upwards may be reasonable, for example where levels of flight activity are high and sufficient accuracy can be obtained in fewer hours, or where collision risks are highly critical and therefore more extended survey is needed to put the information beyond doubt. If developers choose to depart from the standard then this should be fully justified. Relevant factors may be the proportion of observation time during which birds are aloft, the likely variability in flight activity due to weather or other factors, the extent to which information from adjacent vantage points is comparable, and the degree to which the collision assessment is critical in arriving at a view on whether or not there is adverse impact on the bird species.

49. The recommended minimum is that 36 hours of watches should be conducted at each VP for each season (breeding, non-breeding, migratory) when the species is present. Each season should be regarded as a discrete observation period. Within each season, each part of the wind farm should be watched for at least 36 hours. If half of the proposed wind farm area has been watched for 36 hours, for example, and the other half has been watched for 36 hours (with no overlap in visibility areas), then the proposed wind farm area has been watched over for 36 hours (the time spent observing each part of the proposed wind farm), and NOT 72 hours (the total time spent in observation). **It is important that this is addressed during the establishment of VP methods as part of scoping proposals**.

6.4 Breeding upland/peatland waders

6.4.1 Survey methods

50. **Surveys for breeding waders should take place out to a distance of 500m from the proposed wind farm site**. For most species use the Brown & Shepherd (1993) survey method. This method involves two visits to the survey area, one early in breeding season and the second at a later date. The first visit generally aims to detect earlier breeding species (e.g. curlew) and territorial display in later breeding species (e.g. golden plover), and the second visit aims to detect birds alarm calling when they have chicks. The Brown & Shepherd (1993) method, like many survey methods, is sensitive to the timing of survey visits: visits which are too late or too early can miss vital stages of the breeding season which generate records of evidence of breeding. Timing of breeding varies geographically and annually. It can be sensible, therefore, to plan for and undertake **three** survey visits (which should be undertaken **April to July**) in order to ensure that key phases of the breeding cycle are not missed, especially in areas where existing information on the timing of breeding is absent.

51. Unfortunately this method, designed and tested for survey of some upland wader species over large areas, has been inappropriately used by some

assessment studies. The following cautionary statements need to be emphasised, therefore:

- The method should not be used for raptors or waterfowl or for birds in non-upland habitats.
- It is NOT appropriate for all upland breeding wader species: refer to Gilbert et al. (1998) for those species for which it is appropriate and for methods for other species (e.g. whimbrel, dotterel, and typically lowland species).
- All survey visits should be undertaken in the same season; splitting survey visits between years (e.g. visit 1 in year 1, visit 2 in year 2) is not valid.
- Observation time during a Brown & Shepherd (1993) survey does not count towards observation time conducted under Vantage Point watches: the two methods are not consistent in design or objectives.
- Locations of records of breeding birds from a Brown & Shepherd (1993) survey represent points where a bird has been seen displaying some evidence of breeding. They do not indicate precisely where nest sites are. Wader brood movements can be extensive and some species can display over several hundred square metres of ground. A Brown & Shepherd survey merely picks up a snapshot of such movements. This limitation of a Brown & Shepherd survey should be acknowledged in an assessment, which should account for the likely home range of birds throughout the breeding season.
- The method does not provide a sound quantitative estimate of the number of birds present, but it leads to an index of bird activity, enabling different parts of the site, and different sites, to be compared.

52. The method can probably be safely adapted for some passerines of open uplands or scrubby habitats (e.g. ring ouzel, whinchat) as it is similar to several species-specific methods (Gilbert et al 1998 – note the difficulties and requirements for twite survey, however). Typically, the method as developed for waders is to record after about 09:00 in the morning (Brown & Shepherd 1993). By extending the method to include the hours between dawn and 09:00, passerines can be included within a survey (meadow pipits are generally the exception to this as densities are often too great to be quickly and accurately estimated). See section 3 for a proposed open ground method for upland birds in winter.

6.4.2 VP watches

53. Breeding waders of conservation interest should be included as target species during VP watches: these can be combined with VP watches for other target species i.e. VP watches can simultaneously collect data on breeding waders and breeding raptors. These should be timed to occur **March – July**, and

should involve **at least 36 hours of observation** from each VP and be stratified to record periods of flight display when flight activity may be greatest. Display tends to be more common earlier in the season. Other flight activity can be more common immediately before and after dawn and in the evening around twilight e.g. golden plover during changes in incubation shifts when birds may fly to off-site grassland feeding areas. From March to mid-April golden plover may also fly between breeding sites and off-site grassland according to weather conditions before breeding commences. Such temporal patterns of activity should be reflected in the temporal pattern of VP observations in order to efficiently record more potentially risky flight line observations (though observations should also be conducted at other times to gain a representative picture). The decision on which wader species to include as secondary species should depend on how many other target species are selected and the capacity of observer effort to cope with a limited number of species and/or activity.

54. Where more intense observational effort has been used during periods of expected greater flight activity, it is important that such observational bias is corrected for in collision risk estimation otherwise risk will be overestimated. The average observed flight activity (eg in bird-seconds per hour) should be calculated separately during the periods of high and low flight activity, then multiplied by the total time (in hours), over the period of analysis, of high and low flight activity respectively. This will yield the total flight activity (in bird-seconds) during the period of analysis. In effect the observations provide a sample of the overall time, stratified in two categories, high and low flight activity. Increasing survey effort during the periods of high flight activity increases the sample rate during the periods of greatest importance, and therefore improves the reliability of the flight activity conclusions.

6.5 Diurnal raptors

6.5.1 Survey methods

55. A useful general guide to monitoring raptors is Hardey et al, 2005 (in prep). Survey methods for locating nest sites are described by Gilbert et al (1998). Distances beyond the wind farm site for which surveys should be conducted are given in Table 1.

Table 1. Distances beyond the wind farm site for which information on breeding raptor nest site locations should be gathered. These distances are approximate representations of the 'core' ranging distances for raptor species, with the exception of golden eagle and white-tailed eagle where the distances incorporate a wider extent of likely ranging distances (but for these species information on nesting locations with respect to a wind farm site should be available from existing sources – SNH, RSPB or SRSG).

Species	Survey distance (km)
Golden eagle	6
White-tailed eagle	6
Peregrine	2
Hen harrier	2
Short-eared owl	2
Merlin	2
Goshawk	1
Red kite	2
Osprey	2

6.5.2 Survey effort

56. For most species there should be a **minimum of survey spanning one year**. For several species, especially in areas where there is an active SRSG, additional years of survey information may be held by SNH, RSPB and local SRSG workers. SRSG data may not be available free of charge and are the property of SRSG members, so restrictions on confidentiality and circulation must be respected. Such data should always be supplemented with new contemporary survey, extending beyond the wind farm boundary in line with the recommendations of Table 1. Where available, full use should be made of contemporary survey undertaken by SRSG members. It is important that survey is carefully coordinated with SRSG workers and good working relations are maintained. Information on breeding success over several years can prove very useful in interpreting likely effects of wind farms on raptors (and other birds) because it can provide an insight into annual variation in the activity of birds and the 'quality' of the pair and/or territories which may be involved (although persecution can depress breeding success even if the inherent quality of a pair/territory is high). **Any existing available information on the breeding performance at breeding sites which may be affected should always be incorporated in the assessment.** One example of this would be if the year in which observations had been conducted had been particularly good for breeding success then bird activity rates would probably be concomitantly lower on average over the lifespan of the wind farm, both because flight activity of breeding birds and numbers of young would be lower. Also, it is obvious that if a productive territory is adversely affected then the impact of a proposal will be greater.

57. Note that the distribution of some species like hen harrier and short-eared owl (and therefore their use of any area) can vary substantially from year-to-year. It is recommended, therefore, that **for proposals in known breeding habitat of hen harrier and short-eared owl at least two years of nest site survey should be gathered**. If more than two years of survey (and measures of breeding success) are available then these should be used: at least five years is ideal. If previous years of survey (e.g. from SRSG) are not available then two years of novel survey should be undertaken to give at least an indication of how distribution of these raptors may vary annually. Merlin can also regularly switch breeding sites, and if burning of heather occurs frequently then this may force ground nesting pairs to switch breeding sites more often. In such situations, two years of survey for merlin should also be gathered as a minimum.

58. More than one year's survey should also be used where nesting or feeding behaviour is dependent upon land use patterns which change annually, for example due to crop rotations.

59. For resident and more 'traditional' species, such as goshawk, white-tailed eagle, golden eagle and peregrine, range use (and therefore use of any area within the range, such as a proposed wind farm area) is also likely to vary if widely separated alternate nest sites are used in different years. For example, in golden eagles it appears that range use may vary according to nest site if alternate nest sites are at least 2 km apart (McGrady et al 1997, McLeod et al 2002b). This is also likely to apply to white-tailed eagles and peregrines. It is important that such changes should be accounted for in the assessment. For kites, ospreys, eagles and most peregrines information on use of alternate nest sites should exist through previous surveys, so in most situations novel survey will probably not be required to document the availability and use of alternate nest sites.

60. Species such as buzzard, sparrowhawk and kestrel, should not be ignored and should be included in survey within 1 km of the proposed wind farm site for one year. Note also that merlin can nest in open moorland or in trees and, rarely, on cliffs.

61. As described earlier, survey data give only limited indications of birds' use of the site within and between years, especially for species which show low site fidelity and species which may switch between alternate nest sites. Breeding survey data shows the location of nest sites but does not show how birds from those nest sites may use an area in the vicinity, such as a proposed wind farm site. Breeding survey data also does not necessarily show how a site may be used in the non-breeding season by resident adults or by non-breeding birds if the site does not involve breeding adults. To document use of an area additional methods are needed.

6.5.3 VP watches

62. The timing and minimum duration of VP watch effort is given in Table 2. Note that the recommended efforts for different species are minima: estimates of use

improve with amount of time spent in observation. Effort at each VP during the breeding season should be commensurate with the likelihood that target raptor species will be nesting within or close to the proposed site. These recommendations refer to the duration of observation from each VP, and do not refer to the total effort across all VPs. Appendix 2 provides some discussion and examples of when it is appropriate to vary VP effort. Multiple observers may be required if levels of flight activity are such that a significant proportion of data may be lost while tracking one bird.

Table 2. Recommendations for the season(s) for which VP watches should be conducted and (therefore) the minimum annual effort on watches from each VP for diurnal raptor species.

*Notes: As in all recommendations of VP effort these figures refer to **the time spent watching from each VP** – not the total time spent at all VPs.*

The breeding season differs between species but generically can be taken as mid-March to August, and the non-breeding season as September to mid-March.

Species	Season of VP watches	VP min effort (hr)
Golden eagle	Year-round	72
White-tailed eagle	Year-round	72
Peregrine	Year-round[2]	72
Hen harrier	Breeding/year-round[1, 2]	36/72
Short-eared owl	Breeding[2]	36
Merlin	Breeding[2]	36
Goshawk	-[3]	-[3]
Red kite	Year-round	72
Osprey	Breeding	36

Notes: [1] Some sites may hold breeding birds and non-breeding birds in winter.
[2] Seasons are given for a proposal in areas of breeding habitat. Clearly, in areas which may hold non-breeding birds in winter (e.g. coastal or lowland agricultural areas) the relevant season should be non-breeding (Sept - mid-Mar).
[3] Due to this species spending a high proportion of activity below tree canopy it is unlikely that useful VP observations can be collected for goshawk.

63. **Observations should be spread through the day, between dawn and dusk**. During the breeding season observers should pay particular attention to any breeding display flights and the flight behaviour of dispersing young as birds may be prone to collision when engaged in these activities. It is important that any observational bias towards periods of greater activity is corrected for in collision risk estimation otherwise risk will be overestimated (see para 54). Hence, it is also important that observations are spread temporally to account for all phases of the breeding cycle and, for resident species, between the breeding and non-breeding seasons as behaviour can change through and between the seasons. Note that short-eared owls are also active at night and the assessment should account for this. It is likely to be very difficult to obtain

representative observations for merlin and VP watches will probably underestimate the activity of this species; hence, it is difficult to model collision risk quantitatively for merlin based on VP observations. VP observations are unlikely to give any useful information for goshawk. Note also that the non-breeding distribution of more social species such as hen harrier, white-tailed eagle and, especially, red kite can be different when activity is often centred on roost locations.

64. As for survey effort, VP watches should not ignore other species: even when target species are being prioritised, secondary species can include buzzard or kestrel, for example (see Appendix 1). The decision on which species to include as secondary species should depend on how many target species are selected and the capacity of observer effort to cope with a limited number of species and/or activity.

65. VP watches should be conducted for **at least one breeding season, non-breeding season or year**, depending on whether the raptor interest is breeding, non-breeding or year-round respectively.

6.5.4 Accounting for annual differences in site use

66. For some species breeding bird use of an area may vary substantially between breeding seasons due to either low site fidelity (hen harrier, short-eared owl) or known use of widely separated alternate nest sites (e.g. white-tailed eagle, golden eagle, peregrine). VP watches should therefore ideally be conducted for at least two breeding seasons for hen harrier and short-eared owl. For those species where area use may depend on the location of alternate nest sites, two seasons of observations are only fully useful if conducted in years when alternate nests are used. Where this is not the case, alternate means of describing likely changes in use of the proposed wind farm site are required.

67. One means by which this can be achieved is to conduct surveys of prey and/or habitat on which prey is reliant at sampling locations within **and** outwith the wind farm site. These can be used to gain an insight into the relative importance of the wind farm site compared to other areas which may be available to the same birds. Survey methods will be conditional on the most relevant prey for the raptor in question e.g. field voles and meadow pipits for hen harrier. **Such prey survey methods are essential if for those species such as hen harrier or short-eared owl two breeding seasons of VP observations will not be conducted or if pairs of other raptor species use well-separated (> 2km) alternate nest sites.** Note that shifts in nest sites and activity patterns may mean shifts in VP locations may help.

68. Prey/habitat surveys also provide an important insight into why raptors may be using the site and therefore the effect of any displacement from the site (one of the fundamental objectives of an assessment) and, for example, the scope of any prey/habitat enhancement which will be necessary off-site to counteract any displacement.

69. Ideally, for pairs of eagles, year-round VP observations should be conducted that record the entire range use of the pair which may be affected by a wind farm (rather than just concentrating on recording use within the wind farm site alone). Assessments which carry out such entire range observations have been conducted and are undoubtedly superior to those which do not, as it allows a quantification of the importance of the wind farm site to the pair in question and therefore the impact in terms of the extent of range loss which displacement from the wind farm would entail. Such loss may of course be unsustainable, but this method also allows a wind farm to be located in an area where range loss can be avoided or minimised and can identify those areas where counteractive prey enhancement would be best managed.

70. For breeding golden eagles, whole range use can be estimated using the PAT (Predicting Aquila Territory) model in a GIS (McLeod et al 2002a, b). While actual observations of range use are always preferable, and may identify prey hotspots exploited by golden eagles which the model would not predict, the PAT model can be useful in providing an indication of the potential importance of a proposed wind farm site to breeding golden eagles at a very early stage of the assessment process. It also allows all the advantages gained by entire range observations, as described above. The PAT model can also readily examine the effects on range use of a change in use of nest site, something which may take many years of observations to document. **In all proposals involving occupied ranges of golden eagles the use of the PAT model is recommended as an element of assessment**.[4]

71. The PAT model does not attempt to describe ranging behaviour of non-breeding sub-adult golden eagles or adults which do not occupy breeding ranges. In most part of the Highlands and Islands, if an area is not within the range of a breeding pair of golden eagles, it is likely that the area will be used by non-breeding (usually sub-adult) eagles and so this use, year-round, should be accounted for by VP observations (see Table 2 for recommended minimum effort).

72. Range use in raptors can be affected by their reproductive status during the breeding season. Moreover, and more obviously, in years when breeding is successful, young will be present and at risk of collision, but will not be present in years when breeding is unsuccessful. Clearly, **annual breeding success will vary over the lifespan of a wind farm (typically 25 years) and it is essential that an assessment accounts for this variation**. For pairs that are generally successful, if fieldwork occurs in an unsuccessful year then an additional year of fieldwork should be conducted. For species or pairs with a typically low annual reproductive output (some pairs of golden eagles may only rear young infrequently, for example) an additional year of survey is unlikely to 'capture' a successful breeding season. In such a situation, without recourse to several years of fieldwork (the ideal) assumptions will have to be made about likely or known differences (from the scientific literature) in bird activity (e.g.

[4] The model is fully described in the references noted above. A service to run the model using purpose-written software is available from Natural Research Ltd, tel (01330) 826536 email stephanie.carey-miller@natural-research.org.

frequency of adult hunting flights, juvenile flight and dispersal behaviour) and incorporated in to the assessment.

73. For traditional roosts of non-breeding hen harriers observations should be undertaken in the first hour after dawn and in the last hour before dusk, noting the flight behaviour (time, height, direction) of approaching and departing birds and birds flying around the roost site. For roosts within 1 km of a proposal, it is recommended that at least 36 hours of observation should be collected, for roosts within 2 km of a proposal at least 18 hours. Observations should be made from September to March, with effort spread evenly through the season unless a roost is known to be important for passage birds when effort can be more concentrated during the passage periods (September, October, March). Some roosts can be temporary and occupied for short periods only, and roosts can also be occupied during the breeding season, so monitoring should accordingly be flexible.

6.6 Breeding waterfowl, notably divers

6.6.1 Survey

74. Problems may potentially arise through wind farm effects on divers not just if divers nest on the proposed wind farm site but also if the site lies on a line between the divers' nest site and feeding areas so that divers fly through the site to reach and/or return from feeding areas. For black-throated divers, feeding areas can be lochs (or, less commonly, the sea) away from the nesting loch, and for red-throated divers feeding areas are normally away from the nesting lochan (usually the sea, sometimes larger freshwater lochs). SNH and RSPB may hold some information on diver distribution (information on the rarer black-throated diver is likely to be more complete), but the survey methods in Gilbert et al. (1998) should be followed to provide an additional year of data. Refer also to Gilbert et al. (1998) for survey protocols for other species of waterfowl. For all species **a minimum of one year of novel survey is required**: if more years are available they should be used as part of the assessment. Note that non-breeding divers may also be present even if there are no records of breeding. Hence in any area where either species may occur a dedicated survey should be conducted irrespective of the presence of prior breeding records.

75. Both species of divers may feed away from their nest site and so there may be a risk affecting these species even where nest sites are absent from the proposed wind farm site. **As a minimum, an area of within at least 1 km of the wind farm site should be surveyed for divers and other breeding waterfowl (but see below for guidance involving proposals which may involve designated sites).**

76. For red-throated divers, survey effort should be concentrated landward of the site relative to potential feeding areas of sea lochs or the sea. They may fly up to 8 km from their nest site to reach feeding areas (Eriksson et al. 1990), and

judging by the distance to the sea of some red-throated diver nest sites in some parts of Scotland, a minority of pairs may fly greater distances. Hence if the wind farm site lies within 8 km of a red-throated diver breeding site and a potential feeding area there will be a possibility that divers will fly through the site. The area that divers may overfly can be crudely estimated by assuming that they are equally likely to fly within an arc or quadrant bounded by lines that are 8 km from the nest site to the feeding area. So, for example, for a wind farm site that is well inland with only a few scattered lochans the number of potential nesting sites that will require checking will be relatively small and readily achievable. On the other hand for a coastal wind farm site with a large number of potential nesting lochans inland the area that would require survey would potentially be very large and it is probably impractical to conduct a detailed survey of all potential nesting areas, unless some or all of those nesting sites lie within a designated site for the species when all potentially relevant parts of the designated site should be surveyed.

6.6.2 VP watches

77. Divers are vulnerable to collision due to their flight behaviour and anatomy (wing loading): they are powerful fliers but not manoeuvrable. Surveillance of the wind farm site for divers flying through the site should be done during the pre-breeding and breeding season **(late April to August) for at least one year and for a minimum of 36 hours at each VP (red-throats) or a minimum of 48 hours (black-throats). For black-throated divers which are known or suspected to use alternate breeding sites at least two years of observation are required.** (This surveillance can be combined with observations of the use of the site by other species.) For red-throated divers **additional observation should also be conducted at VPs from where each nesting lochan (and incoming and outgoing flights) within 1 km of the proposed development site can be observed**. **For proposed development sites that lie on a potential route between the sea and a designated site for red-throated divers, such additional observations should be conducted at every nesting lochan for red-throated divers which may potentially be affected** (see the section on survey for determining those nesting lochans where pairs may be affected). The objectives of these additional VP watches is to confirm flight routes, the number of pairs which contribute to any observed flights through the wind farm site and, if necessary, to record flight activity rates to allow the estimation of collision risk. The first step in these observations should be to collect sufficient records to assess if flight routes intercept the proposed wind farm location. Observations should be sufficient to record at least fifteen incoming flights (although outgoing flights should also be recorded): diurnal flight activity appears to be greatest early and late in the day and so these periods can be targeted to obtain records most efficiently. If the flight routes do not lie in the direction of the proposed wind farm then no further observations should be necessary. If the flight routes lie in the direction of the proposal site then further observations should be conducted to estimate the number of flights which occur per day, to estimate collision risk.

78. **Observations should be collected during the period of one hour before dawn to one hour after dusk, using light-intensification equipment if necessary since divers can fly at night. There should also be some observations conducted during conditions of low cloud or mist as divers will continue to fly under such circumstances and flight routes can vary with weather conditions.** Of course, it is unlikely that such VP watches will reveal sightings but auditory records may be possible. Great care should be taken not to disturb nesting divers when selecting VP locations and visiting VPs, especially when setting up observations before dawn.

79. It is also important to appreciate that flight activity in a breeding season can vary according to whether a pair has successfully hatched and reared a chick, as flights will be far more frequent for pairs which are rearing a chick than for non-breeding or failed pairs. Assessments should account for this variation, as variable patterns of breeding success will likely be encountered over the lifespan of the wind farm. Also note that flights by non-breeding pairs and nest site prospecting pairs and 'social' flights of groups or pairs of birds can occur which do not involve birds flying to marine feeding areas. Such flights can be more common early in the season. Some pairs also make feeding flights to freshwater feeding sites.

6.7 Woodland species

6.7.1 Survey

80. Several woodland species have been covered under other sections (e.g. woodland owls, woodland nesting raptors such as goshawk, buzzard). Species-specific survey methods have been developed for several woodland birds (e.g. crossbills, black grouse) and, either for reconnaissance survey or where woodland birds have been identified as target species, these methods should be followed as appropriate (e.g. Gilbert et al 1998).

81. For black grouse, known lek sites and other areas of suitable habitat which can host leks (Gilbert et al 1998) should be identified and **visited at least twice during mid-April to mid-May within 2 hours of dawn** on calm, dry days with good visibility. Visits should involve listening and scanning for lekking blackcock from strategic VPs (avoiding disturbance of leks) and during walks between these VPs ensuring that all potential habitat is covered. When a lek location is confirmed, it should be revisited within three days to count the number of males (not just displaying males) and females seen in the one hour before to one hour after dawn. **The maximum count of males in the 2 hours around dawn** gives the standard count estimate, but the maximum number of females seen should also be presented. Treat leks that are at least 200 m apart as separate leks. Survey estimates should be gathered for at least one breeding season. **All leks for woodland grouse species should be identified within 1.5 km of the proposed wind farm site.**

82. The ‘standard’ survey method for species associated with Caledonian pinewoods (e.g. Scottish crossbill, crested tit, capercaillie) involves survey in winter (Gilbert et al 1998). This method is designed to cover large areas and so, for the purposes of site-specific assessment of impacts on these species, it is imperative that nest sites or lek sites should be surveyed additionally within the wind farm site area for such species of conservation interest.

83. In native woodlands a mapping method using the approach of the Common Birds Census (CBC) method (Gilbert et al 1998) should be used to document the breeding bird community and the wintering bird community but restricted to three visits spread at representative dates across the season of interest. For site-specific surveys, the BTO’s Breeding Bird Survey (BBS) method is not appropriate as it does not provide the level of detail required by assessment.

84. A generic method for estimating the abundance of more common breeding woodland species of young commercial plantations (especially small passerines) involves carrying out counts at selected points (Bibby et al 1985, 1992). This method, which employs randomly selected points, is often not suitable for older commercial forests when due to the density and height of closely-packed trees it can be impossible to access every randomly selected point and to record bird activity and distance with confidence. In such situations, a simple inventory of species present is a more realistic objective and can be gained by selecting accessible points stratified across different forest types and/or successional stages, no closer than 200m apart, or within 100m of the forest edge (M Madders in litt.). Each count point should be visited at least twice and preferably three times, once or twice from mid-April to May and once in the first three weeks of June in the first six hours after sunrise but not in conditions which may affect bird detection rates e.g. strong winds (>Beaufort 4), rain or snow, mist. The first visit can detect resident species and, depending on the timing of the visit, some migrants; the second visit can record migrants some of which may have been missed on the first visit due to timing. The same observer should not be used on both visits to the same point.

85. Counts should be delayed for a few minutes after the observer arrives at a point (habitat features can be recorded in this period) to minimise any disturbance effects. Thereafter, the observer should record all birds seen and heard during a 5 minute period. The habitat at each point should be recorded, paying particular attention to broad habitat type (native conifer, plantation conifer, broadleaf, mixed conifer/broadleaf) and the forest growth stage (establishment, developing pre-thicket, pre-thicket, thicket to high forest, clear fell) and rotation phase.

86. The survey should also be repeated at least twice during different periods of winter.

87. The value of this method is that it can readily allow simple measures of bird communities or species to be associated with different woodland habitat types. As some felling will be necessary for a wind farm located within forest and the forest may change over the lifespan of the wind farm, it can allow a prediction of the potential bird community post-construction. As the data may be limited, such predictions should also take into account normal expectations of species

composition based on typical habitats. If any of the likely habitats that will be present post-construction (e.g. clear fell) are not present on the site pre-construction, then it may be helpful to visit relevant habitat at another location nearby and undertake point counts.

6.7.2 VP watches

88. In line with generic guidelines, assessments of wind farm sites which wholly or partially involve areas of woodland may require VP observations. Allow at least 36 hours of observation at each VP for the breeding season (mid-March to August) and 36 hours at each VP for the non-breeding season (September to mid-March), with additional effort for any migratory interest that may overfly the wind farm site (e.g. wildfowl). Even if a commercial conifer plantation is thought to be of low bird interest, it is important that this is demonstrated rather than simply assumed. In several cases assessments have had to be extended because a commercial forest has been assumed initially to be of little importance, but subsequent information has come to light which suggests it may, for example, lie on a migratory pathway, requiring additional study. Assessment should always attempt to anticipate such possibilities because, as described in the background sections, an absence of information does not equate to an absence of bird interest.

89. At some sites with large forest plantations where landscape relief is minimal VP watches are unlikely to yield useful results. Furthermore, if a proposal involves the felling of woodland, pre-construction VP observations will not give an indication of post-construction use or collision risk for those woodland species or other species which nest in the vicinity and so they have little utility in this context. Note also VP observations have little utility in assessing use or collision risk for goshawk, regardless of any habitat alteration during construction. Therefore, the main requirement for VP observations is for proposals which involve the felling of woodland within the proposal site and which therefore require assessing use and collision risk for those species which may overfly the site, regardless of the habitat present, and which may continue to overfly the site post-construction.

6.8 Owls and other nocturnal species

6.8.1 Survey

90. Species such as owls, nightjar and woodcock which are exclusively or largely nocturnal in activity pose special problems for assessment because, obviously, activity and use of the site occurs mainly under conditions of restricted visibility. This largely affects the capability to undertake VP observations, as for all species survey methods have been devised to overcome visibility problems. Although there are recognised difficulties in studying nocturnal activity, this should not be seen as a means of dismissing its relevance. Indeed, nocturnal activity may pose greater hazards for birds at wind farms.

91. Survey methods have been published for tawny owl, barn owl, woodcock and nightjar (Gilbert et al 1998). Long-eared owl can be surveyed by listening for calling birds in a similar fashion to that used for nightjar, although visits earlier in the season may be more appropriate. Playback techniques may be helpful in stimulating call responses. Surveys for owls are usefully assisted by signs of occupation such as moulted feathers and pellets, as for diurnal raptors.

92. Survey should be undertaken within **500m of the wind farm site for all species, except barn owl, which should be surveyed within 1 km** of the proposed site. **At least one year of survey** should be undertaken.

6.8.2 VP watches

93. Without resorting to radar studies or other remote techniques assessing site use for nocturnal species is clearly difficult. Crepuscular VP watches can be conducted in the two hours around dawn or dusk, however, and are probably most useful for barn owl due to its pale plumage. For nightjar at least 25 hours of observation should be conducted on calm dry evenings from June to mid-July; for barn owl at least 48 hours of observation should be conducted year-round. Light-intensification equipment augmented by infra red spotlight may prove helpful for these observations.

94. VP watches for largely nocturnal species can be more safely conducted within the wind farm site (cf Appendix 1) as the observer is less likely to be a disturbance, and visibility over longer distances will be impossible. VPs should preferably be located to record flight activity within 200m of the wind farm site. Although survey methods for several species rely on crepuscular observations, it is unlikely that conclusive VP observations can be collected for tawny owl and long-eared owl. VP observations will also probably underestimate barn owl flight activity.

6.9 Lowland/farmland species

6.9.1 Survey

95. As in all other situations a desk based review of available site information, and reconnaissance surveys are invaluable, in order to identify whether there are any target species requiring detailed survey and impact assessment.

96. A territory mapping method such as a ‘scaled down’ three visit version of the CBC is most appropriate for many lowland breeding species (see section 6.3.1). The BBS method is not appropriate for site assessment studies as it is designed for survey of large areas (Gilbert et al 1998) and does not necessarily produce the type of detailed site-specific information required for wind farm assessment. Several birds of conservation interest occur in the lowlands such as, for example, some gamebirds (e.g. grey partridge, quail), spotted crake and

lowland waders, and assessment of sites known or potentially important for such species when breeding should include appropriate survey methods (Gilbert et al 1998). Species specific surveys for BoCC red-listed passerines should only be undertaken when the generic territory mapping method is not deemed suitable (Gilbert et al 1998).

97. A winter survey method involves following a pre-plotted route on the survey site and ensuring that each part of the site is approached to 50m (30m for field boundaries), starting early in the morning and not in conditions of poor weather, such as high winds or rain. The route should be walked slowly using periodic scanning with binoculars at least three times in a winter, spread at representative intervals between September and March, the start point being randomly selected each month. Essentially this is the same as the method for the breeding season.

98. Surveys should be conducted within 500m of the proposed wind farm site and should be conducted over at least one year.

99. Crop type or other forms of agricultural land use can be influential on bird distributions and abundance, and will likely vary through the course of a wind farm's lifespan. Hence assessments on farmland sites should record habitats as part of surveys and use habitat associations to attempt to predict any changes in bird communities and impacts (including collision risk) which may occur over the course of the wind farm's lifespan.

6.9.2 VP watches

100. In line with generic guidelines, where there are target species identified for which detailed flight activity information is sought, proposals for wind farm sites in lowland/farmland should involve VP observations. Allow at least 36 hours of observation at each VP for the breeding season (mid-March to August) and 36 hours at each VP for the non-breeding season (September to mid-March). Additional effort may also be required, appropriately timed, where there is any migratory interest that may use or overfly the wind farm site (e.g. wildfowl).

101. For species which may occur at relatively high density and are relatively insensitive to human disturbance, such as lowland passerines, the method to express indices of use and risk adopted by many USA wind farm studies (e.g. Anderson et al 1999, Strickland et al 2000) is probably more appropriate than the VP watch methodology which has been designed to assess use at sites where densities may be low and species are potentially sensitive to observer disturbance. Essentially, the method commonly used in USA wind farm studies utilises point counts conducted within and in the environs of the wind farm area, during which observations of flight height are recorded within a relatively short recording period.

6.10 Wintering and migratory waterfowl, notably geese and swans

6.10.1 Survey

102. Wintering geese, swans and other waterfowl are at risk of collision with wind farm turbines if flight paths to and from feeding sites or roost sites take birds through the wind farm site. Substantial information on these species is already held by SNH, RSPB, WWT (for geese) and BTO (for waterfowl). If information on the use of the area around the wind farm site is incomplete, not recent or if there is a possibility that birds vary in their use of roost and/or feeding areas, follow the census methods given by Gilbert et al. (1998). Note that where wintering wildfowl are found or known to frequent the area, several visits through a winter will be necessary to determine usage (**at least twice per month: October to March**). More observations, concentrated in a period within the non-breeding season may be needed if it is already known that flocks shift their feeding or roost sites seasonally.

103. Observations should be conducted over **at least one winter**: if flocks are known to shift their feeding or roosting sites between winters then at least two winters of observation are recommended, especially if there is no other detailed recent source of information on flock movements.

104. **For sites which may be used by migratory wildfowl, survey should be conducted September to November (autumn migration) and March to mid-May (spring migration)**. **As turnover can be high during migration, counts should be undertaken more frequently than for wintering birds; at least every week.** Surveys should be undertaken in at least one set of migration periods i.e. at least one spring migration period and at least one autumn migration period.

105. If birds are not found to use the site as a feeding area on any observation day, searching for the location of the feeding area of wildfowl flock(s) away from the wind farm site will facilitate interpretation of the likelihood that birds may use the wind farm site. Similarly, searching the wind farm area and its environs for signs of wildfowl presence (counts of droppings) can help determine if feeding birds are using the wind farm site by night or on days previous to survey visits.

6.10.2 VP watches

106. The standard VP methodology should be followed (Appendix 1). **There should also be some observations conducted during conditions of low cloud or mist as wildfowl will continue to fly under such circumstances.** Of course, it is unlikely that such VP watches will reveal sightings but auditory records may be possible. Auditory records will not provide good information on numbers of birds, but will at least provide information on the flight routes used in such weather conditions.

107. For sites which may potentially affect birds flying to and from roost sites, **observations should be conducted one hour before dawn to one hour after dawn and one hour before dusk to one hour after dusk**. If a roost site may be affected the number of birds may be large and require more than one observer to take records (M. Madders, unpublished: see Appendix 1). For sites which are close to feeding sites or may intercept flights between feeding sites, **observations should be conducted at additional hours of the day**. When observational effort is targeted towards periods when risk is highest around dawn and dusk it is important that this bias is accounted for in collision risk estimation (see para 54). Time spent in VP watches should be as follows (note that as in all recommendations of VP effort these figures refer to the time spent at each VP and not the total time accumulated at all VPs):
    - **for wintering birds, at least 36 hours of observation at each VP (October - March);**
    - **for spring migration, at least 36 hours of observation at each VP (March – mid-May);**
    - **for autumn migration, at least 36 hours of observation at each VP (September - November).**

108. **Observations should be conducted for at least one winter, or where the birds are present only during migration, for at least one spring and one autumn migration period**. If flight behaviour is known or thought to vary between years (due to changes in feeding or roost sites, for example) then VP watches should be conducted over at least two years.

109. As described in section 6.9.1 in agricultural settings crop or field type can be influential on goose movements and potential proximity of geese to a wind farm site. It therefore needs to be accounted for over the lifespan of the proposed wind farm.

6.11 Coastal species

6.11.1 Survey

110. Coastal sites can involve a range of different bird communities, potentially involving a diverse range of breeding birds such as seabirds and species typically of lowland or upland terrestrial habitats. Intertidal species like wildfowl and waders may pass through proposed wind farm sites on migration or when commuting to and from roosting sites in the non-breeding season. North Sea coastal sites can be subject to influxes of northern migrants in autumn.

111. Survey methods should be appropriate to the species concerned (Gilbert et al 1998), and should extend to at least 500m beyond the proposed wind farm site for seabirds. At least one season of survey should be conducted.

112. For non-breeding waders and wildfowl, surveys (Gilbert et al 1998) should attempt to discover the feeding grounds and roosting site(s) of any birds which

may potentially fly through or over the wind farm site. For waders, roost site choice can differ at night and according to the tidal cycle.

6.11.2 VP watches

113. In line with generic guidelines, proposals for coastal wind farm sites in lowland/farmland should involve VP observations wherever there is potential for a significant effect on birds. Allow at least 36 hours of observation at each VP for the breeding season (e.g. mid-March to August) and 36 hours at each VP for the non-breeding season (e.g. September to mid-March), with additional effort appropriately timed for any migratory interest that may use or overfly the wind farm site (e.g. wildfowl). Migratory activity is often weather-related and so targeting observations when relevant weather is anticipated can be more profitable than simply accruing observation hours. Due to the diverse range of coastal bird communities which may be present, there can be considerable differences between species' breeding and non-breeding seasons (e.g. some resident coastal passerines may be breeding in March while non-breeding waders may not depart for northern breeding areas until May). Given this degree of overlap, the safest assumption is to conduct at least 72 hours of VP watches spread across the year, with additional effort (see section on wintering wildfowl) during migratory periods (which can vary according to species). At least one year of VP observations should be collected.

114. Most intertidal non-breeding waders continue to be active at night when flight behaviour can differ from daytime, and flight behaviour can also vary with tide height, weather and season. VP observations on sites which may involve flights of non-breeding waders should be stratified according to tide height (neap tide and spring tide roosts often differ) and should include observations conducted at night (night roosts can differ from daylight roosts). Obtaining data on nights when flights to or from roosts may coincide with high tides close to dawn or dusk may be particularly useful. Coastal sites are often subject to 'falls' of autumn migrants which often fly at night, as can wildfowl. Night time VP watches may be limited in their usefulness to conditions when some visibility is possible, even with light-intensification equipment and infra red spotlight and/or appropriate and judicious use of 'normal' spotlight.

115. Note also that seabird flight activity and colony occupation can vary substantially according to current and recent historical breeding success. As described under the section on raptors, it is important that the assessment accounts for this variation.

7 Taking account of trends or changing habitats

116. There may be situations where the bird interest on a site is subject to change for reasons unconnected with the proposed wind farm: for example where a species is in decline due to grazing pressures or afforestation, or in recovery

due to improved habitat management or creation of new habitats. A few species (e.g. sea eagle or red kite) may be recently reintroduced and therefore re-establishing a stable population, while others may be recovering after periods of persecution. The aim of the environmental assessment should be to identify the impact of the proposed wind farm, comparing the outcome on birds if the wind farm were to be built with the outcome if it were not. Therefore it is important that such trends in bird populations and changes in habitats are recognised and included as part of the assessment.

117. Rarely, a wind farm proposal may be located in an area where the habitat has been recently damaged or destroyed e.g. by a fire through heather moorland. This produces difficulties in terms of assessment of effects on the bird interest that will be present for the lifespan of the wind farm since, until habitat recovery has taken place, the likely bird interest will be reduced or absent (including during the period when assessment should take place). This in turn requires a greater effort in terms of the assessment which is required, since there is greater uncertainty in potential effects and, in effect, the likely bird community and its use of the site will have to be 'constructed' by remote means.

118. Proposed steps to overcome this uncertainty are as follows:
    - Utilise any available information on the bird community present on the site (and in the relevant buffer distances around the site) from previous years prior to damage. This information can include BTO Atlas data, regional atlas data, or targeted species surveys. For a site within the range of golden eagle pairs, the PAT model can predict likely use of the site.
    - Undertake survey and VP watches on any undamaged parts of the site.

119. If historic information is absent, incomplete or over five years old:
    - Undertake bird survey, VP watches and prey surveys on a comparable area in the vicinity using appropriate methods and observation effort as given elsewhere in this guidance.
    - Assess the habitat and topography of the site before damage in detail from aerial photographs and/or satellite imagery and, in combination with similar habitat descriptions and bird and prey survey from the comparable area in the vicinity, construct an estimate of the bird community present and possible nest site locations.
    - The resulting estimates of the bird community likely to be present in the absence of damage should be cross-validated by comparison with density estimates drawn from studies of bird densities in the region for similar habitat types.

120. For predicting collision mortality, estimates of likely frequency of flights through the wind farm area and of typical flight heights will have to be drawn from studies on other sites (and may also include novel VP watches on a comparable site in the vicinity).

8 Assessment of associated infrastructure impacts

121. Assessments of proposed wind farms should also consider the effects of associated infrastructure:
    - Survey methods appropriate to the bird species involved should be conducted either side of access tracks and borrow pits at distances appropriate to the species/group concerned, as described above.
    - If the grid connection is overhead, surveys appropriate to the bird species involved should be conducted within distances appropriate to the species/group concerned, as described above. The route should be divided in to sections, each section being the area visible at up to 2 km (or a shorter distance if the main target species are small or the 'risk window' posed by the power line is narrow) from the nearest VP. Each power line route section should be subject to at least 36 hours of VP watches in each season when collision with overhead wires may be a risk. Thus, for example, breeding season (mid-Mar – Aug: 36 hours per VP), non-breeding season (Sept – mid-Mar: 36 hours per VP), wildfowl migration seasons (Sept - Nov, Mar – mid-May: 36 hours per VP for each season). Refer to relevant sections above on different bird groups/habitats for timing of observations.
    - If the grid connection is underground, surveys appropriate to the bird species involved should be conducted within 500m of the connection route (this distance has been selected as a measure of an upper limit at which most species may be disturbed at the nest during construction).
    - The risk of collision posed by an overhead grid connection or disruption of habitat posed by an underground grid connection must be estimated quantitatively.
    - If the grid connection is overhead, power poles should be of a design that does not present a risk of electrocution to birds which may use them as perches.

9 Recording flight activity

9.1 Taking account of observer error

122. Where several VPs are required to cover the whole site, it is recommended that at least some of the observations should be made simultaneously from a number of VPs. Simultaneous observations are of particular importance when large numbers of birds may be visible in a short time window (e.g. when skeins of geese are in flight). The main benefits of simultaneous observations are:
    - When examining any differences in bird use between different parts of the wind farm, simultaneous observations across all parts removes the likelihood that any observed differences are due to temporal sampling issues.
    - When areas of visibility from VPs overlap, simultaneous observations can also be used to identify the level of some observational errors. Errors can include birds being missed, and inaccuracy in recording flight paths. The VP method requires birds and their flight paths to be recorded at often

considerable distances from the observer, so some recording error is inevitable.

123. For the same reason, different observers should be rotated between the different VPs so that observer identity as a potential source of bias can be documented and accounted for. When there are several VPs, the same observer should not be used repeatedly at the same VP. The VP methodology requires a high level of observational skill and it is expected that suitably trained and experienced staff are used. Observational error should be explicitly incorporated in to assessments of impact.

9.2 Flight height assessment

124. Flight altitude records can also be prone to bias and so some mechanism to ensure record accuracy should be employed (see also Appendix 1). Observers should be trained in the recording of different heights from a distance, and a period of training and familiarisation should be conducted at a site prior to formal observations starting. Comparing observer estimates of the heights of objects against their known heights can be used in training and post-training in the estimation of error. Such objects can include use of kites/balloons suspended at known heights which are unknown to the observer and use of features of known height in the landscape. Just as for error in recording flight path, error in flight height estimation should preferably be examined and explicitly incorporated in to assessments.

125. Appendix 1 gives some guidelines for recording of flight heights in bands relevant to the heights swept by rotors. As turbine tower height increases with advancing technology, flight heights recorded as either above, within or below the heights swept by rotor blades may be difficult to interpret by future studies. Hence, it is generally preferable to record flight heights in several bands referenced to the height above the ground (e.g. in 10m or 20m intervals), although confidence that flight heights are being accurately recorded under a protocol with many height bands may only be possible from VPs that are located relatively close to the study site. Whilst a greater number of height bands may be more useful for future studies, a balance should be struck between this and ensuring that the measurements are accurate, since more 'detailed' measurements (more flight height bands) are liable to be more prone to observation error, especially from more distant VPs.

126. The use of laser range finder binoculars to reduce inaccuracies in distance estimation should be considered, both as a training device and for use in the field.

9.3 Use of automated sensing systems

127. The costs and practical constraints associated with undertaking human observations makes the use of automated sensing systems highly desirable to

gather data on the trajectories and volumes of birds passing through a wind farm site, and to obtain data on actual collision rates. For species which are active by night, the level and characteristics of night-time flight activity is often a major uncertainty, and in the dark, levels of turbine avoidance are likely to be lowest and collision risk highest. The use of radar systems for monitoring in these circumstances is strongly to be recommended. Such automated sensing systems are as yet at an early stage in development, and relatively costly, but may be the only satisfactory means of securing the necessary information. A report on the use and effectiveness of radar and other remote monitoring systems has been published in draft and will shortly be finalised by COWRIE (Desholm et al 2005).

128. The authors have found that low-powered surveillance radar as used in conventional marine navigation systems offers the simplest means of tracking bird movements in two dimensions, to provide an overview of the location and number of bird flight trajectories out to a distance of several kilometres. On its own, this can provide useful supporting information on the volume and location of bird movements. Such systems cannot discriminate between species, and therefore require associated sampled visual observations to identify species. They can be used in conjunction with vertically mounted radar to detect flight heights in addition. For post-construction monitoring of actual bird collisions, Thermal Animal Detection Systems which utilise infrared imagery offer the best opportunity. These are effective at all times of day and can discriminate adequately between species. Ideally they should be used in tandem with a surveillance radar system enabling any changes in overall bird activity within the wind farm area to be monitored.

9.4 Use of data in collision risk assessment

129. Estimation of predicted collision mortality can be undertaken with a model such as that developed by SNH (Scottish Natural Heritage 2000b). The model and supporting documentation can be obtained at the SNH website (www.snh.gov.uk). Band et al (in press) provide further details, worked examples and discussion. The model leads to an initial estimate of collision risk based on the theoretical assumption that birds take no avoiding action. It is then necessary to build in a more realistic expectation that a high proportion of birds are likely to take avoiding action successfully (see SNH 2000a). Limited information on avoidance rates is available for some species, based on experience at actual wind farms (see SNH 2004).

130. Additional notes concerning the collision risk model are as follows:

- Depending on the distance of a bird from the observer, there may be a considerable error in plotting flight lines on a map. Subsequent collision risk analysis should allow for these errors, by ensuring that the areas for which collision risk is calculated are sufficiently large that an error of, say, $\pm$ 200m in flight line recording will not unduly affect the calculated risk.

- In general, it is preferable if flight activity per unit area is calculated separately for that part of wind farm site visible from each VP. The results should be averaged using a weighting to reflect the VP coverage, or, better, the collision risk may be calculated separately for each VP and the risk summed (note that this is an extension of the method described in SNH 2000b). This enables any particularly problematic parts of the proposed wind farm to be identified.

- Further guidance on use of the model is available from the SNH website and it will be periodically revised to account for new information.

10 Reporting survey results

10.1 Recording the data

131. As a general rule, results should be reported in as much detail as possible, since this allows their consideration by SNH and the consenting authority without recourse to additional requests for detail, incurring unnecessary delay. Full presentation of results also facilitates their use by other parties, for example within the context of cumulative assessments. Some considerations worth highlighting are as follows:

    - Occasionally an environmental assessment has acknowledged that survey or other methods of assessment are incomplete, but that such outstanding work will be completed post-construction as part of 'monitoring'. Such work should not be considered as monitoring because assessments should be completed before planning permission is considered.

    - Estimates and details of the assessment of impacts should be presented for each target species identified at scoping stage as requiring impact assessment, even if the impact is deemed to be negligible. Such 'negligible impact' estimates will require to be checked by SNH and the consenting authority, and may be invaluable for future cumulative assessments; hence they should be readily available.

    - Collision risk estimates should be presented separately for each season (e.g. breeding and non-breeding season estimates for resident species); and separately for different age classes (e.g. breeding adults and immatures/juveniles) where the characteristics of the species enable that information to be recorded. Sufficient data should be provided to allow collision risk estimates to be independently checked. The reasons why birds may enter a wind farm area may differ between seasons (e.g. seasonally different food supplies), and population effects of adult and immature mortality are different. Note also the points made on collision risk estimates in section 9.

- The location of VP watch points and the area of visibility from each VP should be presented as a map or maps which show the arc in which the observations were conducted. The map should also show the location of the proposed wind farm.

- Details should be provided in tabular form of all forms of survey conducted. Timing, duration, observer identity, location of each VP watch observation period, walk-through survey routes, plus associated weather conditions, should all be presented in an appendix.

- Estimates of all observed flight heights and durations should be presented, distinguishing when possible between heights associated with different behaviours (e.g. display flight, hunting) or age/sex classes according to date and time of day. Such information is useful to check results and to determine consistency in flight behaviour across studies and so refine future assessments, although it is often very difficult to attribute behaviour such as hunting for a bird in flight.

- Maps showing the locations of all survey records of birds/nest distribution should be clearly presented in map and tabular form. Agreements on the distribution, publicity and retention of data owned and supplied by external parties, such as SRSGs, should be respected.

- Contextual information is also likely to be required within the Environmental Statement, on population numbers, trends and distributions, against which to gauge the significance of the projected impacts. Regional measures of mortality, reproductive success and dispersal may also be helpful in enabling the predicted impacts on the wind farm site to be viewed within a regional context.

- Information should be provided on the bird observation experience of the staff employed on the field survey team, as the quality and reliability of the data is wholly dependent on that experience.

10.2 Confidential annexes

132. The assessment of environmental impacts is to be made publicly available; this is a requirement of the Environmental Impact Regulations. Hence information on, for example, levels of activity, flight heights, breeding densities, and collision risk estimates should be included in the main environmental statement and made publicly available, if they are required for the environmental assessment. However there is no obligation to make publicly available any detailed information which, through its release, might endanger that species through the prospect of crime or increased disturbance. Therefore, results showing the nest site locations of rare or specially protected species should be presented separately in a confidential annex, along with any information such as eyrie names or flight lines obviously emanating to and from discrete points that would allow ready interpretation of nest site locations. Only information in a form

which does not allow nest sites to be identified should be included in the main statement as publicly available data.

133. It should be noted that SNH, the Scottish Executive and local authorities are subject to Freedom of Information and Environmental Information Regulations, which requires them to release any information they have to a member of the public who seeks it unless in certain circumstances. Such circumstances enable the restriction of information whose release might lead to harm to the species. It is therefore important that confidential annexes include only that information which it is necessary to keep confidential. If developers are in doubt about what information should be restricted, SNH staff can advise.

134. It should be noted that developers may from time to time impart other information to SNH or consent authorities on a 'commercial in confidence' basis. Such information may also, if requested by the developer, be subject to provisions of confidentiality. However such information should not form part of an environmental assessment which is open to the public.

11 Acknowledgements

135. Many thanks to Mike Madders for many helpful comments on earlier drafts and contributing the basic vantage watch methodology and advice on methods for divers and forest passerines. Sam Gardner collated comments from several sources on earlier drafts, and Ian Bainbridge, Rowena Langston, Alan Leitch, Iain MacDonald, Colin MacFarlane, David Patterson, and Valerie Wilson also helped with comments and suggestions. Thanks are also due to the many from the renewables industry, ornithological consultants, local authorities, voluntary organisations and one private individual who responded to our consultation on an advanced draft and who have thereby helped to shape this guidance.

12 References

136. An exhaustive discussion of the philosophy and principles that should be followed when assessing the impact of a potential or existing wind farm has already been produced (Anderson et al. 1999). The reader is referred to the original source document that is available from the website of the National Wind Coordinating Committee (NWCC) (www.nationalwind.org). Other useful documents on methodologies, that are also available at the NWCC's website, include Gauthreaux (1996), Erickson et al. (2000) and Morrison & Pollock (2000). Erickson et al. (2001) reviews studies in the USA of the effects of wind farms on birds and provides comparisons of wind turbine collision mortality with other forms of collision mortality. The Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats 2003) has also produced a useful review, which includes several principles which should be

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Appendix 1

Methods statement for Vantage Point (VP) watches

This guidance has been adapted by SNH from information and text provided by Mike Madders, Natural Research.

Background

Vantage point (VP) watches are a means of quantifying flight activity of bird species of conservation importance that take place within the wind farm envelope, with the principal aim of determining the likely collision risk. Activity patterns and time spent flying within the turbine envelope may also allow an assessment of the consequences of *displacement* assuming that the turbines are built.

Further background is given in Section 6.1 of the SNH Guidance.

Purpose

The purposes of vantage point watches are to:

1. Collect data on *target species* (see Section 3.2 of main text) that will enable estimates to be made of:
    - The time spent flying over the defined survey area;
    - The relative use of different parts of the defined survey area; and
    - The proportion of flying time spent within the upper and lower height limits as determined by the rotor diameter and rotor hub height.
2. Calculate an index of flight activity for other species - *secondary species* (see Section 3.2) using the defined survey area.

Methods

Information is collected during timed watches from strategic vantage points (VPs) covering the defined survey area, which encompasses the turbine envelope and extends anything from 200m to 500m beyond the outermost proposed turbines. In the majority of cases, a 200m extension is sufficient to deal with inaccuracies of position for flight line observations.

1. The survey area should not be too restrictive otherwise there is a danger that chance effects will have a large influence on the recorded flight activity. The envelope, including the 200-500m extension (see above) reduces the risk of failing to record birds that use the wind farm area only occasionally.
2. When selecting VPs, the aim should be to cover all of the survey area such that no point is greater than 2km from a VP. It is very important that VPs are chosen parsimoniously in order to achieve maximum visibility with the minimum number of points. However, separation may be reduced where it is

necessary to ensure reliable observations e.g. for smaller species. Ideally, it will be possible to scan an arc of up to 180^{o} from each VP. Larger arcs are difficult to scan efficiently. In exceptional circumstances it may be possible to observe the entire survey area from a single VP. In most cases, however, two or more VPs will be required. For example an upland site in Scotland measuring around 10km^2 typically requires three or four VPs. It is important to minimise the observer's effect on bird behaviour. For this reason VPs are best located outside the survey area where possible. As acuity of observations will decrease with distance, VPs should be located as close to the survey boundary as possible. VPs should not be located near to the nest site of target species and observers should try to position themselves inconspicuously so as to minimise their effects on bird movements. This often precludes the use of hill summits for VP observations. Obviously, VPs should never be located within the proposed wind farm site, but if there is *no alternative* but to locate VPs within the wind farm site, then this should only be undertaken when the proposed site is sufficiently large that a part of the wind farm site at least 500m from the VP can be watched (observations at closer distances are potentially biased). Analytically, such potential bias can only be checked for if the area surrounding a VP within a wind farm site is also observed from another VP away from the wind farm site when there is no observer present at the within site VP (i.e. compare the observed bird use during potentially biased conditions against the observed bird use during unbiased conditions). If the observed bird use in the area surrounding the VP within the wind farm is not different with or without an observer present, then this would suggest that the observer has not biased the observation conducted within site. However, considerable effort may be required to generate sufficient records to make such a comparison. When several observers are involved it is advisable to mark the exact location of each VP on the ground, as in some situations, even 8-figure GR may be insufficient to ensure consistency in observer position. Because it is critical that the spatial coordinates of VPs are measured to the highest level possible, using a Global position System (GPS) is strongly recommended.

3. Watches are undertaken between dawn and dusk (though note requirements for nocturnal and crepuscular species) by a single observer under conditions of good ground visibility (>3km). For exceptions see relevant sub-sections within Section 6 (e.g. 6.8.2 for nocturnal owls). Use of more than one observer simultaneously may be required when the number of individual birds is large: responsibilities for taking records of different species and/or individuals should be clear to ensure no errors. When flightlines need to be tracked across large distances (e.g. simultaneously recording records of diver flights from a VP overlooking a nest lochan and from a VP at a distant proposed wind farm site) means of rapid communication between observers will be necessary. The cloud base should be higher than the most elevated ground being observed. In some instances and for some species, observations may be necessary in conditions of low cloud base: clearly in conditions of such visibility will be impaired but auditory records may be possible to indicate if the target species continue to be active under such conditions. Ideally such observations should be made in a range of wind conditions. This is particularly important in the case of soaring birds when wind direction and strength is likely to have a large effect on ranging

behaviour. Regular measurement of wind using hand held anemometer is advised in order to investigate the magnitude of this effect.

4. Each watch should last a maximum of three hours but can be suspended and then resumed to take account of changes in visibility (e.g. fluctuations in the cloud base). Experience from field trials suggest that the acuity of most observers declines after three hours, and some may prefer to conduct shorter watches. A gap of at least one hour between watches is advisable. A shorter gap might be used if the watch is shorter than three hours.
5. More detailed guidance for different species groups can be found in the main body of the guidance text.
    - For breeding waders see Section 6.4.2;
    - For breeding & wintering raptors, see Section 6.5.3;
    - For breeding and wintering waterfowl & divers, see Section 6.6.2;
    - For woodland birds, see Section 6.7.2;
    - For owls and other nocturnal species, see Section 6.8.2;
    - For lowland farmland bird species, see Section 6.9.2;
    - For wintering geese and swans, see Section 6.10.2; and
    - For coastal species, see Section 6.11.2.
6. During each watch, two hierarchical recording methods are used to record data: focal animal sampling for *target species*; and activity summaries for *secondary species*. These are as follows:

    a. Focal animal sampling. The area in view is scanned until a *target species* is detected at which point it is followed until it ceases flying or is lost from view. The time the target bird was detected and the flight duration are recorded. The route followed is plotted in the field onto 1:25 000 scale maps. The bird's flight height is estimated at the point of detection and then at 15 second intervals thereafter, using, for example, a count-down timer with an audible alarm. Note that this does not apply to display flights of hen harrier and short-eared owl. A 15 second interval is recommended as a practical compromise that aims to minimise dependency within data while maximising the sample of observations. If necessary, the data can be re-sampled after *post hoc* analysis (e.g. using a one-sample runs test). Flight heights can be classified as <10m, 10-100m, or >100m; depending on rotor blade dimensions and rotor hub height, <20m, 20-100m, or >100m, or other height bands reflecting rotor swept area as appropriate. If conditions allow a finer resolution of height bands (e.g. presence of features of known height) then more detailed observations of flight height should be made. Training and checking of observer accuracy in relation to height estimation should be made and accounted for where this is possible. Use of a clinometer and range finder provides one means of determining flight heights accurately. Observations of target species take priority over completion of activity summaries (b).

    b. Activity summaries. Each watch should be sub-divided into 5 minute periods, at the end of which the number and activity of all *secondary species* observed should be recorded. If a *target species* is being tracked at the end of a 5 minute period, then the activity summary for

that period should be abandoned and a new one started once observations of the target species have ended. Observation of target species take priority over recording of secondary species. Note that the number of birds recorded should be the minimum number of individuals that could account for the activity observed. Static and flying birds should be recorded separately. Observers should record perched birds and birds on water bodies once only on arrival at the VP, and the area or site used marked on a map. Thereafter only flying birds and newly noticed perching/swimming birds should be included in the activity summaries. This allows greater time for focal animal sampling, rather than repeated observations of the same static birds. It is simpler to record unusual movements (e.g. flights of gulls) as a separate event rather than incorporate them into 5-minute activity summaries. Wind speed and direction should be recorded as frequently as possible, preferably as part of the 5-minute activity summaries.

At the end of each watch, the locations and activity indicative of breeding by divers, raptors and all other *target species* should be recorded on the map.

7. For some analyses it is necessary to calculate the amount of time birds spend per unit area of ground surveyed. The use of several VPs can therefore complicate the analyses of collision risk as described by Band *et al.* (in press) because overlap in visibility means that some parts of the survey area will be observed for longer than others. However, a more statistically robust method is to calculate activity per unit area on the basis of watches from each VP (i.e. the activity is calculated per VP and the un-weighted mean of these measures is used as the metric for input into collision risk models), then this source of error should not arise. However, if the areas for each VP are widely variant, then there may be a need to use an area-weighted mean, assuiming the survey time for each VP is broadly consistent (see paragraph 131 of main text). Visibility from each VP can be mapped in the field , from photos taken from each VP, or using terrain data within a Geographic Information System (GIS). Software used to predict the Zone of Visible Influence (ZVI) of wind farm developments, such as Windfarm 2000™, can be useful in this respect.

8. Mapping in the field or from photographs tends to overestimate visibility because observers are unaware that some areas are hidden from view. This is particularly true when convex slopes or undulating terrain are being viewed. In general, therefore, use of GIS is to be preferred. However, in habitats with much woodland or other tall vegetation it will be necessary to make allowances for the effects on visibility of the vegetation relief. Note that in areas of complex terrain or vegetation relief, visibility can alter with small changes in observer position. It is therefore critical that the spatial coordinates of VP positions be are measured to the highest level of accuracy possible, using a GPS. Also as noted earlier, observers should take care to re-use the exact VP location in successive watches.

9. Birds are often visible when the ground they are flying over is not. Thus birds can sometimes be seen flying or soaring over hidden valleys and watersheds. Since a key purpose (see above) is to estimate the risk of collision with turbines, it is the visibility of the airspace with the turbine rotors (the collision

risk volume) that is of prime importance. Therefore it is recommended that visibility be calculated using the least visible part of this airspace i.e. an imaginary layer suspended at the lowermost height passed through by the rotor blade tips (typically about 20m above ground level). Predicting this visibility at this level is a simple task using GIS.

For other methodological issues see main body of text (especially Section 6) and SNH guidance on estimating collision risk (reference?)

Notes

- Although all points within the survey area are required to be within the 2km of a VP, observations from each VP are not constrained to a 2km radius (i.e. birds are recorded regardless of their distance from the VP).
- At further distances there will be a bias in favour of records of larger target species (geese, swans and large raptors), compared to smaller species such as waders, and raptors such as merlin, which are less easily visible.
- The location of displaying hen harriers and short-eared owls should be recorded as accurately as possible on the maps (including start and finish point, plus extent of display area). Record the duration of display, number of oscillations – counted as number of dives – and the estimated minimum and maximum flying height.

Recording

Data should be recorded on two forms (referred to as 'Form 1' and 'Form 2') and 1:25 000 map(s). Form 1 [activity summaries] must be completed for each VP watch, regardless of whether target species were recorded or not. Use different forms for different watches (i.e. do not combine data from different watches onto one form or map). Forms used should encapsulate the observations listed below and, of course, record start and finish times, observer name, weather records and VP location (cross referenced to the map).

Form 1 Activity Summaries

- Use BTO species and activity codes.
- Record *target species* on both forms, but those not in flight will appear on Form 1 only.

Form 2 Focal Sampling

- For each watch number each flying bout consecutively. Cross reference this number to the flight path recorded on the relevant map.
- Record the time the bird is first detected to the nearest minute e.g. 15:45.
- Record duration of flying bout to the nearest second.
- For each flying bout: starting at 0 (zero – point of first detection), number each 15 second interval consecutively, and tick appropriate flying height for each 15 second interval.
- Rule off under each flying bout to highlight end of recording.

Map(s):

- Mark the location of the VP used and if a GPS is used then cross refer GPS location to position on map.
- Mark flight paths of *target species* and indicate direction of flight. Use different colours and symbols for each species. Provide key on back of form.
- Number each flying bout and cross reference with Form 2.
- Use additional map(s) if data records are cluttering initial map.
- Include information on displaying owls and hen harriers on a separate sheet, but ensure that it is included with all other data sheets and enough information is recorded enabling cross reference with other forms and maps.

SNH, October 2005.

Appendix 2

Effort used in VP watches

The main objective of vantage point watches should be to gather sufficient observations so that a representative measure of total bird activity is obtained. In statistical terminology, we observe a sample but want to apply the conclusions to a population.[5] Any analysis should be able to extract from the sample worthwhile information about the population, and the problem of validity is to whether the sample allows us to form conclusions that reasonably apply to the population in which we are interested i.e. whether the sample observations of bird activity are a representative measure of all bird activity.

The first precaution we can take when considering how to ensure our sample is representative is to take account of any subdivisions in the population. In this case, subdivisions can be seasonal or diurnal differences in bird activity and flight behaviour. In statistical jargon we divide the population into strata, and by taking observations from each stratum we construct a stratified sample (the prerequisite for stratified sampling is that the variation within the strata is less than that within the population as a whole). This is why the guidance suggests that seasonal and diurnal patterns of activity and behaviour, for example, should be accounted for in setting up the observation protocol. Stratification can also allow us, if we assume that flight height, for example, is the same in strata of high activity as in strata of low activity, to increase effort in a high activity stratum in order to more efficiently gather information on flight height. But as we've deliberately increased observation effort in a high activity stratum, then this needs to be accounted for when analysing the results for activity, to be assured that our sample is representative so far as activity level is concerned.

If our sample is representative then its statistics, such as the average and the variance, should be the same as that of the population. In general, if more stratified observations are collected then it is more likely that we have a representative sample, because more of the units forming the population have been measured, but it is also likely that beyond a certain point, more observations do not give us any increases in the accuracy of our sample. If we assume that a very large sample that has been stratified correctly is effectively the same as the population then we can examine the sampling effort at which this point is reached, by examining how the average and variance change with increasing numbers of observations drawn from the larger sample, and looking for the stage (number of sub-samples or observations) at which these sample statistics stabilise at the values for the (assumed) population statistics. Ideally, this exercise should be carried out using a set of VP observations where a large sample with a good stratification has been taken to give us a better idea of what effort is required to give a representative picture.

SNH does not hold such data, however, and therefore it is not possible for SNH to undertake such an exercise (and it is likely that required sampling effort may differ

[5] Note that a statistical population is a different concept to an ecological population.

between species).[6] In reaching the minimum recommendations for VP effort, therefore, we have had to consider what may be most likely to give at least a crude picture of activity and flight behaviour, given the number of strata which can be envisaged. This effort may not give a representative picture, however, so when bird interest is higher, and therefore the potential impact of a wind farm may be higher, effort should be increased to give a better assurance that a representative sample has been taken.[7]

Examples where only the minimum VP effort would be needed could be for a proposal where the only known conservation interest would be breeding golden eagles and the proposed development site lies on the presumed edge of the pair's range (so, for a typical pair, say 5 km from the territory centre or nest site). Or if the proposal was about 2 km from the nearest known hen harrier nest site (so the species could occur in the area but use of the site was unlikely to be high), or that wintering geese were known to occur in the area but flight routes were unlikely to include passage over the proposed site. Essentially the VP observations in these circumstances are by way of confirming that our assumption that use of the site, based on distance to likely centres of activity, is probably low and that the site does not present an unexpectedly high attraction for bird activity (by holding especially rich food supplies, for instance, making it more attractive than would be expected from distance to nest site alone).

Examples where the VP effort could increase would be if the proposal lay closer to the known activity centres of species of conservation interest (so in the golden eagle example, closer to the 'core' of a pair's activity, which typically lies within 3 km from the nest site) or where activity is likely to be greater by virtue of more individuals being involved (so if the proposed site lies on a known flight path of geese moving between roost and feeding sites). Effort may increase still further if the proposal lies close to the known centre of bird activity (so, for example, if it is close to the nearest golden eagle nest site or goose roost site, or if hen harriers are known to nest regularly within hundreds of metres of the proposal). Effort may also need to be increased if the number of species of conservation interest involved is greater, not least because it may be necessary to target some species during some observation sessions and to target others at other times if activity levels are too great for the observer to be able to record all the flight behaviour properly by himself/herself in a single set of observation sessions. Similarly, goose activity or flights of colonial seabirds may be so concentrated in time that a single observer is not sufficient. It also makes sense to increase effort when activity is higher because potential mitigation can involve moving or removing some turbine locations and informing such decisions requires obtaining sufficient observations to give confidence that relative risk associated with particular turbines has been estimated realistically: such mitigation decisions can have important conservation and commercial implications.

Hence, it is important to give careful thought to the level and type of VP effort that is likely to be required, rather than just applying the minimum recommended effort to every situation: in some situations, as described in paragraph 22 of the main text,

[6] We would nevertheless encourage such exercises to be undertaken to inform the issue better.

[7] When bird interest is low we should also be less concerned that a representative sample has been taken because the purpose of the EIA is not necessarily to provide a complete and accurate description of the statistical population, but to provide a judgement on whether the proposal is acceptable.

even the minimum effort may not be necessary but in others more effort than the minimum recommendation will be best. In other situations such as for red-throated divers, it may be more profitable to record the activity of individuals which may be at risk, rather than concentrating all effort at the wind farm site itself. Further examples of this could include recording flight routes to and from roost sites for geese or waders which may be at risk, or recording diurnal changes in flight activity at a nearby seabird colony to stratify better further observations at the wind farm site.

Finally, it is worth reiterating that a thoughtful methodological design tailored to individual circumstances is far preferable to simply taking a set 'preordained' approach. It also helps, therefore, to provide a clear justification at scoping on why a particular level and type of observation effort has been arrived at for the assessment and for there to be flexibility and the capability to respond rapidly to any unforeseen findings once assessment fieldwork is underway. With time and more publications of the full details of assessments and of analyses of bird behaviour which are relevant to assessments of wind farm proposals it is likely that more assumptions about flight behaviour and risk can be made safely in the future, reducing the observation effort that may be needed.