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Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes

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TRANSPORT INFRASTRUCTURE IRELAND (TII) PUBLICATIONS

This original document is part of a suite of documents published by the National Roads Authority (NRA) in the 2000s and early 2010s as part of its 'Four Stage Strategy – The Environmental Integration Model'. These documents were the NRA's *Environmental Assessment and Construction Guidelines* and *Guidelines for the Creation, Implementation and Maintenance of an Environmental Operating Plan*.

For further explanation on the 'Four Stage Strategy – The Environmental Integration Model,' refer to *TII Environmental Strategy Section 4: Delivery Framework.*

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Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes

NRA
National Roads Authority
An tÚdarás um Bóithre Náisiúnta

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DISCLAIMER

CHAPTER 1 INTRODUCTION

In 2004, the National Roads Authority (NRA) published '*Guidelines for the Assessment of Ecological Impacts of National Road Schemes'*. These guidelines were recently updated to incorporate, *inter alia*, the requirements of Article 30 of the 1997 Habitat Regulations (S.I. No.94 of 1997). The purpose of these 'Ecology Guidelines' is to provide guidance on the assessment of impacts on the natural environment during the planning stages of national road schemes.

This document is intended to supplement the 'Ecology Guidelines' by providing advice on procedures and survey techniques to inform the Natural Environment section of the Constraints Study, Route Corridor Selection Study and the Environmental Impact Statement (EIS) for new schemes and improvements. These survey techniques are also intended to be appropriate to be undertaken prior to maintenance activities that could have implications for the natural environment.

Ireland has a large number of species of protected flora and fauna, some of which are rare and have extremely localised and isolated distributions and, for these reasons, will rarely come in proximity to proposed national road schemes, *e.g.* Kerry slug, Killarney fern, natterjack toad. Other species, given their abundance and distribution, *e.g.* badger, otter and bats, are regularly encountered during the planning of national road projects. Ireland also has additional responsibility to protect a small number of endemic species and sub-species, *e.g.* Irish hare and Irish stoat. There are also a number of rare or threatened species that are listed in the Irish Red Data Books or are to be the subject of future listings, which have yet to be afforded any legal protection.

This document provides guidance on generic survey techniques for habitats, plants and fungi; terrestrial and aquatic invertebrates; fish; amphibians; reptiles; birds and mammals. Species-specific techniques are also presented, in the form of 'Key Cards', for those protected species that are likely to be affected by road projects.

Whilst the document focuses on survey guidance, it also presents summary information with regard to the identification of the different species and groups, their habitat requirements, life-cycles and behaviour, along with outline guidance on group- and species-specific mitigation, compensation and enhancement measures (these terms are defined in the relevant sections of the 'Ecology Guidelines').

The Guidelines contribute towards Ireland's obligations with regard to legally protected flora and fauna under the Wildlife Acts, 1976-2000, the EU Habitats Directive (92/43/EEC) and Birds Directive (79/409/EEC), amongst other international legislation and conventions, and form part of the NRA response to the *National Biodiversity Plan* (Department of Arts, Heritage, Gaeltacht and the Islands, 2002), which includes a requirement for all statutory agencies to prepare "guides to best practice" for any activities that have an impact on biodiversity conservation.

In summary, these 'Survey Guidelines' supplement the 'Ecology Guidelines' and present standard procedures and methodologies for surveying of protected flora and fauna, thereby helping to provide a consistent approach to the assessment of ecological impacts of national road schemes.

CHAPTER 2 STRUCTURE OF THE 'SURVEY GUIDELINES'

Chapter 3 of this document presents a summary of key considerations when planning and implementing ecological surveys.

Group-specific and species-specific survey guidance is presented in Chapter 4. Each sub-section is colour-coded and numbered separately to facilitate easy 'navigation' around this part of the document.

Appendix I presents a suggested list of desk study contacts.

Appendix II presents specific guidance on the timing of ecological surveys throughout the year.

Appendix III summarises information on the current legal, policy and conservation status of each of the species for which Key Cards are presented.

Where either scientific or vernacular names of any plant or animal species have changed recently or have been quoted differently on relevant legislation, the alternative names are also identified.

CHAPTER 3 SURVEY CONSIDERATIONS

3.1 Recognising and dealing with key potential constraints/limitations

3.1.1 Seasonal constraints

It is important to recognise that the vast majority of the techniques available to survey plants and animals are seasonally constrained and hence sufficient time needs to be put aside to collect baseline data. In order to collect sufficiently robust data to underpin an EIS for most schemes, an entire survey season encompassing spring, summer, autumn and winter periods will need to be available. In the vast majority of situations, surveys over successive years will not be required. The seasonal constraints on each group- or species-specific survey technique are highlighted as appropriate throughout Chapter 4 and summarised in Appendix II.

3.1.2 Climatic conditions

In addition to seasonal constraints, local and regional climatic conditions can influence the detection of certain species. The design and programming of surveys must therefore retain an appropriate degree of flexibility, weather conditions should always be recorded and reported, and if the effectiveness of the technique appears to have been compromised, surveys should be repeated as appropriate.

3.1.3 Inter-annual variation

Some plant and animal populations vary significantly in size between years; some species exploit resources in a variable manner from year to year; and others may remain undetectable for extended periods. However, since it will generally not be appropriate to undertake detailed surveys over several years in advance of an EIS, professional judgment will need to be exercised in dealing with these issues, based on existing information about the locality, habitats and/or species concerned (e.g. certain species of orchid).

3.1.4 Access limitations

Under certain circumstances access to sites or features that may be of nature conservation importance or that could support protected species will not be available. In each case a precautionary approach should be adopted, relying on observations from the nearest locations for which access can be obtained, coupled with remote information (e.g. aerial photography) and collating any existing information that might be available.

3.2 Survey effort

Survey effort will vary significantly depending upon the target species or group and the complexities of the habitats concerned. The 'Ecology Guidelines' provide details on scoping ecological surveys, based on the spatial and temporal limits of the impacts in question, including setting survey parameters such as corridor width.

In every case, the scope, detail, techniques and boundaries of the ecological surveys undertaken to inform an EIS should be determined on a location, project- and species-specific basis. Nevertheless, it is possible to provide general guidance on setting survey corridors for each of the main groups covered in Chapter 4.

Plants and habitats

It will generally be appropriate to consider potential impacts on statutory designated sites within 2km of roads projects. However, in the case of terrestrial sites, the majority of potentially significant impacts on plants and habitats will be confined to the footprint of the works themselves and any areas subject to remote hydrological and/or hydrogeological effects. Habitats sensitive to air pollution can be affected up to 200m from the road in question. Where road projects has the potential to affect watercourses, impacts should routinely be considered up to 1km downstream, but possible impacts on particularly sensitive 'receptors' may need to be investigated at greater distances.

Terrestrial invertebrates

The distances at which terrestrial invertebrates tend to be affected by road-related activities depend upon the dispersal distances and abilities of the species concerned, and population and metapopulation structure. For sedentary species, 'effect areas' can be limited to the 'footprint' of the works themselves or distances determined by other indirect factors, e.g. remote impact that affect the habitats they rely on. For more mobile species it will be necessary to assess the issues on a species- and location-specific basis, but it is likely that the majority of significant impacts would be limited to within 1km of the project.

Aquatic invertebrates and fish

The considerations for watercourse-related impacts set out above, are relevant to the majority of these species, although their sensitivities to pollution and increased sedimentation vary considerably.

Amphibians

Generally amphibian populations greater than 500m from a road project are unlikely to be affected and significant impacts are only likely within approximately 250m.

Reptiles

There will rarely be significant impacts on reptile populations at greater than 100m from a project.

Birds

Studies have indicated that road projects can have indirect effects on birds up to 1km away, although this varies substantially, depending upon characteristics of the road activities, local environment and bird species. Impacts on migratory birds can necessitate consideration of bird

populations at even greater distances. It is particularly important that the boundaries of study areas for birds are set on a location-, project-, and species-species basis.

Mammals

'Effect areas' will vary significantly between species. Survey boundaries should be set to address specific issues, e.g. the possible presence of setts or den sites, or pathways crossing the line of a new road. Indicative widths of survey corridors are given in the group- and species-specific guidance presented in Chapter 4. Bats (for which significantly greater distances may need to be considered) are not addressed with in this document, since specific guidance is already presented in the NRA publications: *Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes* and *Guidelines for the Treatment of Bats during the Construction of National Road Schemes*.

In addition to the general considerations discussed above, further guidance on survey parameters for individual species and groups is given throughout Chapter 4, including the requirements for repeat inspections.

3.3 Survey standards

As identified in Chapter 1 of the 'Ecology Guidelines', suitably qualified and appropriately experienced ecologists, holding relevant licences where necessary, should undertake the surveys set out in detail throughout Chapter 4. The NPWS should be consulted in situations when doubt exists whether a licence is required to undertake a specific survey. In addition, it is imperative that biosecurity measures are taken to avoid the incidental spread of vector borne disease e.g., crayfish plague and invasive alien species between watercourses during survey work.

3.4 Establishing baseline conditions

Baseline conditions may differ from those at the time of the survey. The anticipated beginning of construction should be taken as the baseline date to inform an assessment of construction-phase impacts. Similarly, the likely status of nature conservation resources during the lifetime of the project should be used as the baseline against which to assess operational impacts. This will require understanding and consideration of the changes that might take place to the habitats and species concerned, as well as their susceptibility to a range of environmental variables. Similarly, it will be necessary to take account of potential cumulative impacts that could occur, to complete the prediction of baseline conditions.

3.5 Monitoring

Monitoring of habitats and species following completion of road projects is important for a number of reasons. The results of monitoring can provide valuable information on the effectiveness of the particular mitigation, compensation and enhancement measures implemented as part of a project. This information can then be used to inform the design of future mitigation on other road schemes and to inform future EISs.

In general, project-specific monitoring schemes is normally carried out in situations where substantial or innovative mitigation, compensation or enhancement measures are undertaken for protected flora and fauna as part of the requirement of a derogation licence issued by the National Park and Wildlife Service (NPWS) of the Department of the Environment, Heritage, and Local Government.

In addition to this, post construction monitoring requirements forms an integral part of the NRA's environmental integration model. Currently, post construction monitoring is carried out under the Authority's Research Programme. In these programmes, a range of mitigation measures are identified that is representative of what is implemented on various national road schemes in different regions and these are monitored over an extended period of between 12 to 24 months. These studies are co-ordinated nationally in consultation with the NPWS.

3.6 Future use of survey information

To aid in the conservation of Ireland's protected species, all surveys carried out as part of road projects should contribute information to the National Biodiversity Data Centre. The ecological data recorded for the surveys should be compatible with the databases utilised by the NPWS and other relevant bodies involved in recording protected flora and fauna and should be forwarded to them at the completion of the Environmental Impact Assessment (EIA) process. The NBDC website www.biodiversityireland.ie provides details of the format in which these data should be submitted.

3.7 Health and Safety Considerations

The focus of this document is to provide guidance on how ecological surveys for protected flora and fauna are undertaken during the planning of national road schemes. While the document alludes to various precautionary measures that should be considered when undertaking such surveys, it is important that relevant health and safety requirements are complied with, including, where appropriate:

- Safety, Health and Welfare at Work Act, 2005;
- Safety, Health and Welfare at Work (Construction) Regulations, 2006;
- Chapter 8 of the Traffic Signs Manual;
- Guidance for the Control and Management of Traffic at Road Works; and
- Safety, Health and Welfare at Work (General Application) Regulations, 2007.

CHAPTER 4 SURVEY TECHNIQUES

4.1 Desk studies

A list of potential sources of ecological information is presented in Appendix I. The 'Ecology Guidelines' provide guidance on the scope of desk study investigations at each stage of scheme development.

4.2 Multi-disciplinary walkover surveys

The multi-disciplinary walkover survey should incorporate habitat mapping and evaluation, grading of hedgerows, and an investigation of riparian habitats at watercourse crossings and downstream, (further information on these habitat assessment techniques is presented in Chapter 4; Group-Specific Guidance Note for Habitats, plants and fungi). This should be combined with a walkover survey to detect the presence, or likely presence, of a range of protected species. Boundaries should be set for different elements of this walkover survey on the basis of the predicted impacts and the characteristics of the survey 'targets', following the principles set out in the 'Ecology Guidelines' with regard to scoping ecological surveys. The content of this walkover survey will vary, but will normally include, as a minimum (across the majority of Ireland), surveys for badger setts, potential bat roosts and potential habitat features for the full range of other protected species that are likely to occur in the vicinity of the route.

The intention should be to undertake all ecological surveys which require an inspection of the entire length of a project and for it then to be possible to restrict follow-up surveys to selected habitats, features or locations. The use of a small multi-disciplinary team at this stage, competent to undertake each of the most relevant surveys, and to scope all subsequent investigations, is by far the most cost-effective option.

4.3 Group-specific and species-specific surveys

Guidance on survey techniques for Habitats, Plants and Animals are described in a series of Group-Specific Guidance Notes (GSGN) and Key Cards. Each GSGN sets out details on the general characteristics of the group, the potential impacts of road schemes upon them, and group-specific survey techniques and mitigation measures.

Each Key Card presents further detailed information on the protected species, including a brief description of each species; summary information concerning its life-cycle, behaviour, and habitat preferences; species-specific survey techniques; optimum survey periods; and an outline of suitable mitigation, compensation and enhancement measures.

In many cases, the survey techniques set out in the remainder of this section focus on reliably determining the presence or absence of the species concerned. The size, distribution and likely nature conservation importance of any resident or transient populations should then be assessed, based on an informed appraisal of the extent, distribution and quality of suitable habitat. A proportion of the techniques also seek to estimate population status or other parameters, or recommend the use of standardised approaches to facilitate comparison (between sites, for example), but only in those situations where contextual information is likely to be available to make this worthwhile.

Box 1 outlines the Group-Specific Guidance Notes and Key Cards included in this document.

Box 1: Group Specific Guidance Notes and Key Cards

HABITATS, PLANTS AND FUNGI
Varnished-hook moss
Killarney fern
Sedges and grasses
Marsh saxifrage
Irish lady's-tresses

AMPHIBIANS
Smooth newt
Common frog

REPTILES
Viviparous lizard

TERRESTRIAL INVERTEBRATES
Marsh snails
Kerry slug
Marsh fritillary

BIRDS
Geese and swans
Hen harrier
Corncrake
Barn owl
Kingfisher

AQUATIC INVERTEBRATES
Freshwater pearl mussel
White-clawed crayfish

MAMMALS
Red squirrel
Badger
Otter
Pine Marten
Deer

FISH
Lamprey species
Atlantic salmon
Shad species
Common frog

Key general survey guidance/identification guides referenced in this document

- Fossitt, J., 2000. *A Guide to Habitats in Ireland*. Dublin: The Heritage Council.
- Hill, D. et al eds., 2005. *Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring*. Cambridge: Cambridge University Press.
- Stace, C., 1997. *New Flora of the British Isles*. 2nd Ed. Cambridge: Cambridge University Press.
- Smith A.J.E., 2004. *The Moss Flora of Britain*. 2nd Ed. Cambridge: Cambridge University Press.
- Sutherland, W.J., 2006. *Ecological Census Techniques: A Handbook*. 2nd Ed. Cambridge: Cambridge University Press.

HABITATS, PLANTS AND FUNGI – GROUP SPECIFIC GUIDANCE NOTE

Group-specific Guidance Note: Habitats, plants and fungi

GENERAL CHARACTERISTICS OF THE GROUP

Changes in land use and management have resulted in the loss and decline of a range of habitats, plants and fungi. Those which are no longer so widespread are now recognised as being of nature conservation importance. Recognised areas of important habitats are distributed throughout Ireland, these include: National Parks, Nature Reserves, Special Areas of Conservation (SAC) and Natural Heritage Areas (NHA). Geology, hydrology, climate change and human activities, such as land management, all influence and affect the distribution of these areas. The distribution of habitats in Ireland ultimately affects the locations where specific plants and fungi can be found. The nature conservation value of a habitat tends to be associated with the plant and fungi diversity and the size of the area.

The plant kingdom includes an array of different species groups including vascular plants such as trees, forbs, grasses and ferns, bryophytes such as mosses and liverworts, and algaes. Although discussed together with the same Group-specific Guidance Note document, fungi are part of a different kingdom and show a completely different life history strategy to plant species. Yeasts, moulds and mushrooms are all examples of fungi.

Botanical names follow Stace (1997) for vascular plants and Smith (2004) for mosses.

POTENTIAL IMPACTS OF ROAD PROJECTS

The most immediate impact on habitats, plants and fungi associated with the construction and operation of roads projects is the loss of land and the species contained therein. However, there are additional indirect impacts associated with road construction which can lead to the degradation of habitats and the consequent loss of species. These are impacts such as changes in local hydrological conditions leading to the drying out of habitats and the consequent loss of species; habitat degradation through increased pollutant and particulate deposition on habitats adjacent to roads; genetic isolation of plant and fungal populations as a result of road construction; and adverse impacts on water quality within watercourses leading to a decrease in species diversity.

Opportunities also exist, in particular within landscape treatments and management of road landscapes to create or enhance valuable habitats.

SURVEY TECHNIQUES

Habitat mapping and hedgerow surveys should be undertaken as part of the multi-disciplinary walkover survey described in Chapter 4. The findings of this survey, along with data obtained during the desk study, should be used to identify any valuable habitats present. This habitat assessment (described in more detail below) should be used to help scope the need for further targeted surveys required to underpin the assessment of impacts of the road project.

SURVEYS TO BE UNDERTAKEN AS PART OF MULTIDISCIPLINARY WALKOVER

Habitat Survey

The initial habitat assessment should be undertaken as part of the multi-disciplinary walkover survey. The habitats present within the survey corridor should be classified and mapped in accordance with Fossitt (2000) to 'Level 3' and Target Notes provided to help inform the habitat classification and to highlight features of particular nature conservation importance. In addition, where available, aerial photographs of the route corridor can be used to help map the extent of habitats. For road projects, it is recommended that habitat surveys are carried out between late-March/early-April and mid-October. Surveys during this time period will coincide with the growing season of most plants.

Species composition assessment

In parallel with the habitat mapping and classification exercise, plant species lists and estimates of percentage species composition of the canopy layers of each of the relevant habitat features should be recorded, to aid in preparation of the Landscape Sections of the EIS and to underpin future landscape treatments (see *Guidelines on Landscape Treatments for National Road Schemes* (NRA 2006)).

Hedgerow survey

Until recently, the status of the nature conservation value of hedgerows in Ireland was largely unknown. A National Hedgerow Survey methodology has been developed to address this issue, following completion of a pilot study in six areas across Ireland, for recording the attributes of a hedgerow. This methodology allows for a hedgerow to be described according to four main categories. 'Location and setting' identifies the farm type, landscape type and altitude in which the hedge is located. 'Situation' describes the adjacent land use and linkages with adjacent habitats. 'Structure and condition' describes the quality, condition and future viability of the hedgerow including characteristics such as its continuous nature and density at the base. Finally, species composition of the hedge is recorded, including percentage cover of shrub species, and whether tree species are present.

The National Hedgerow Survey methodology has been applied in a nationwide assessment of hedgerows, allowing for comparisons in hedgerows across Ireland to be made according to different characteristics. It would be appropriate to apply this methodology to road projects as part of a multi-disciplinary walkover survey, where it can be used to make a qualitative comparison of the nature of hedgerows on a project.

SURVEYS TO BE UNDERTAKEN OF PARTICULAR SITES OR FEATURES

If significant impacts on valuable habitats or species are unavoidable, detailed botanical surveys would be required. These may involve targeted searches for protected species and/or those identified as species of significant nature conservation value in either a Species Action Plan or Local Biodiversity Action Plan. Where a habitat of potential nature conservation value is

identified, more detailed relevé (quadrat)-based surveys may be required. Natural habitats that may be of conservation value are identified in Appendix III of the National Biodiversity Action Plan, but this list is by no means exhaustive, and other habitats may be identified on local Biodiversity Action Plans. It will generally be appropriate to liaise with the National Parks and Wildlife Service (NPWS) and other relevant consultees over the scope and detail of specific botanical surveys, including surveys for the species identified on the following Key Cards.

Where follow-up surveys are required, in the context of habitats, plants and fungi, these will generally include targeted plant community surveys, species-specific surveys, and hydrological assessments, where appropriate.

Where wetland or groundwater dependant ecosystems are present within the study area, consultation should take place with the geologist/hydrogeologist so that these features are accounted for during the survey phase.

Species-specific surveys

If the multi-disciplinary walkover survey and/or desk study has identified the presence or likely presence of a protected species (or a species of nature conservation importance) that would be affected, targeted surveys should be undertaken. Surveys should be conducted during the fruiting/flowering season of the particular species of interest. Targeted 'look-see' searches should be carried out, during which surveyors should undertake an exhaustive search of the habitat features in question (based on the habitat requirements and characteristics of the species). These surveys should be timed to coincide with the optimal time for establishing the presence/absence of the target species. For example, fungi surveys should be undertaken in spring or autumn, dependent on species. Early spring is the optimal time to survey lichens and bryophytes: however, surveys can often be undertaken all year round.

When a survey has confirmed the presence of a protected species or species of nature conservation importance, the location of the individuals/colonies should be marked on a plan and the locations accurately identified using a GPS. An estimate of population size or equivalent should be provided.

Plant and fungal community surveys to assess conservation importance

If the multi-disciplinary walkover survey and/or desk study reveals the presence of habitats or plant/fungal communities that are potentially of nature conservation importance, relevé-based surveys may be required to fully assess the value of these features. However, in the absence of a standardised survey technique for important habitats and plant communities in Ireland, it would be important to liaise with the NPWS and other relevant consultees over the scope and detail of any specific investigations. A technique has been developed for macrofungal surveys (Feest 1999) that would be applicable to surveys for road schemes in Ireland.

River Habitat Surveys (RHS) and River Corridor Surveys (RCS)

Where a proposed road project crosses a watercourse, a RHS and/or a RCS may be required. The need for further surveys of riverine habitats will depend upon the extent of the potential impacts on bank-side and in-channel features, and the apparent nature conservation value of these features. This should be reviewed on the basis of the results of the multi-disciplinary walkover survey. If the physical characteristics of the watercourse and the quality of habitat needs to be assessed, the RHS method produces a score for the different channel and bank features. RHS surveys should be undertaken by an appropriately qualified surveyor.

The RCS method provides information on the vegetation and the physical structure of the watercourse. This method should be used at the location of, as well as upstream and downstream (for at least 1km) of, any proposed crossing points. It provides a record of the channel conditions. These surveys should not be undertaken during or immediately after periods of heavy rainfall while rivers are in high flow or flood conditions.

As well as informing the impact assessment and mitigation design, these techniques generate baseline data to underpin post-construction monitoring.

MITIGATION, COMPENSATION AND ENHANCEMENT

Appropriate mitigation measures should be designed on a site- and project-specific basis in consultation with the NPWS and other relevant consultees. Basic mitigation principles include avoiding or minimising habitat and species loss and any degradation to habitats and species populations, particularly of those protected species and species of conservation importance. Fragmentation of valuable features should also be avoided or minimised in areas where plant populations or habitats of nature conservation importance are present. Mitigation measures should be undertaken to avoid or reduce the impact of the road project. Consideration should also be given to habitat enhancement works to take advantage of any opportunities that arise during the project design. Habitat enhancement works should be undertaken in accordance with the guidance presented in the National Roads Authority's (2006) *Guide to Landscape Treatments for National Road Schemes in Ireland*.

Where avoidance is not possible, mitigation measures should include the use of buffer strips to minimise impacts on sensitive habitats and species, and where appropriate, temporary or permanent protective fencing should be installed to protect sensitive habitats and features. Measures should also be undertaken to ensure that existing micro-climatic conditions in habitats supporting communities or species of nature conservation importance are maintained. This may include for example, the management of rate and quality of run-off from a new carriageway to maintain the hydrological regime and avoid pollution of adjacent wetland habitats. Wherever possible, newly created or enhanced habitats should be located close to retained, similar areas of habitat. Habitat and/or species translocation should be considered as a last resort where it is not possible to avoid impacts on a sensitive habitat or species. Receptor sites for translocated individuals should replicate the micro-climatic, hydrological and management conditions of the donor site.

Key reference

- Feest. A., 1999. A Practical Methodology for surveying the Macrofungus flora, Species diversity and Species richness of a site. *J. Practical Ecology and Conservation*. , p. 23-32.
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- NRA, 2006. *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes*. Dublin: National Roads Authority.
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KEY CARD:

Varnished hook-moss

(*Hamatocaulis vernicosus*)

Description

This moss (formerly known as slender green feather-moss) forms green to yellow-green/brown, and rarely red-brown, patches. It has hooked shoot-tips, and branched stems with numerous strongly-curled leaves. There is a lack of population data for varnished hook-moss, but it is thought that the occurrence of this species has declined due to loss of suitable habitat.

Varnished hook-moss (*Hamatocaulis vernicosus*) Photo: Niall Lockhart, NPWS.

Habitat Preferences

Varnished hook-moss occurs in 'micro-habitats' within bog, fen and flush communities. It is thought to be sensitive to eutrophication, occurring mainly in mesotrophic fens. It can be found at elevations up to 450 m, in nutrient-poor fen, base-rich flush systems, and springs in the Irish uplands and, more rarely, in wet lowland sedge meadows. There are at least nine known populations of varnished hook-moss in Ireland, the core areas of its distribution being in Co. Mayo and Co. Galway. It is also known to occur in Donegal, Westmeath and Waterford.

Survey Techniques

Where areas of suitable habitat have been identified within the route corridor, targeted searches should be carried out to confirm presence or absence of this species. If presence is confirmed, further surveys should be undertaken to establish the size of the population, and the distribution of the species should be mapped. GPS and GIS mapping of the locations of important plant species can subsequently be invaluable to both mitigation and monitoring. The methods outlined in the '*Species-specific survey*' section of the GSGN for habitats, plants and fungi apply in respect of varnished hook-moss.

Optimum Survey Period

Surveys for varnished hook-moss are not seasonally constrained and can be undertaken throughout the year. In most cases, however, the most efficient approach will be to carry out these surveys as part of a wider detailed botanical survey, which may be seasonally constrained by the flowering of other important plant species.

Mitigation, compensation and enhancement

The principles outlined in the '*Mitigation, compensation and enhancement*' section of the GSGN for habitats, plants and fungi are generally relevant to varnished hook-moss.

The most important mitigation measure is avoidance and, failing that, minimising the loss of varnished hook-moss habitat. This can be achieved through the choice of sensitive route alignments that avoid habitat that supports or is suitable for the species.

Mitigation measures should seek to address both direct and indirect impacts on the species and its supporting habitat. The major threats to populations of varnished hook-moss arise from habitat loss, changes to the local hydrological regime, and alterations to the nutrient balance within supporting habitats. Nutrient enrichment that increases the primary productivity of supporting habitats is likely to result in adverse impacts on varnished hook-moss, through out-competition by other, more vigorous, species. In addition, varnished hook-moss is associated with partially-shaded habitats; alterations in the levels of shading (e.g. by removal of trees and scrub, or alterations to management regimes such as grazing) could also result in adverse impacts on the species.

If impacts on varnished hook-moss cannot be avoided, it will be necessary to undertake a site-specific review with the NPWS and other relevant consultees to determine appropriate mitigation, compensation and enhancement measures. The translocation of individual plants or communities should be seen as a last resort, since finding a suitable receptor site with appropriate ecological, hydrological, soil and shade characteristics is likely to be problematic.

Key reference

- Averis, A.B.G and Stewart, N.F., 1995. *Red Data Book of European Bryophytes: Important Areas for Bryophyte Diversity in Ireland*. Trondeim: European Committee for Conservation of Bryophytes.
- NPWS, 2007. *Conservation Assessment of Slender Green feather-moss (Hamatocaulis vernicosus (Mitt.) Hedenas) in Ireland. Conservation Status Assessment Report*. Dublin: National Parks and Wildlife Service.
- Smith, A.J.E., 2006. *The Moss Flora of Britain*. Cambridge: Cambridge University Press.

KEY CARD:

Killarney fern (*Trichomanes speciosum*)

Description

Killarney fern has translucent fronds (leaves), which can be up to 450mm in length. This species is highly sensitive to desiccation. There has been a historic decline in the distribution of Killarney fern in Ireland, though it is currently considered to be in 'favourable conservation status'.

Killarney Fern (*Trichomanes speciosum*) Photo: David Tipling, naturepl.com

Life-Cycle

This species has a typical two-stage life-cycle. The first stage is the filamentous gametophyte, and the second is the fern-like sporophyte, both of which are capable of asexual reproduction.

The gametophyte is able to exist and reproduce independently of the sporophyte.

Habitat Preferences

Killarney Fern requires humid and densely-shaded conditions. It is found at elevations of 50 to 380m on acidic substrates with northerly aspects. It occurs in damp caves, rock crevices on cliff faces and adjacent to waterfalls, and rarely, it has also been recorded within the ground flora of damp woodland. In these habitats, both the gametophyte and sporophyte occur together and the sporophyte occurs on its own. Colonies have been identified within woodland comprising beech (*Fagus sylvatica*) rhododendron (*Rhododendron ponticum*) and cherry laurel (*Prunus laurocerasus*). The core range of the Killarney Fern in Ireland is in Counties Kerry and West Cork, with populations also occurring in Limerick, Carlow, Clare, Donegal, Waterford, Wicklow and Sligo.

The gametophyte stage of the Killarney fern's life-cycle occurs independently in less humid conditions than those described above. This life stage of the Killarney fern also occurs in Counties Mayo and Galway.

Survey Techniques

Where areas of suitable habitat have been identified within the route corridor, targeted searches should be carried out to confirm the presence or absence of this species. If presence is confirmed, further surveys should be undertaken to establish the size of the population, and the distribution of the species should be mapped. GPS and GIS mapping of the locations of important plant species can subsequently be invaluable to both mitigation and monitoring. The methods outlined in the '*Species-specific survey*' section of the GSGN for habitats, plants and fungi apply in respect of Killarney fern.

Optimum Survey Period

Surveys for the Killarney fern should be undertaken between June and August, when individuals are at their maximum development and are easiest to locate and identify in the field.

Mitigation, compensation and enhancement

The principles outlined in the '*Mitigation, compensation and enhancement*' section of the GSGN habitats, plants and fungi apply to Killarney fern.

The most important mitigation measure is avoidance or, failing that, minimising the loss of Killarney fern habitat. Avoidance can be achieved through revisions to route alignment that avoid habitat features that support or are suitable for the species. Where avoidance is not possible, effective mitigation, compensation and enhancement measures to protect populations of Killarney fern from the impacts of the road development should be designed in consultation with the NPWS and other relevant consultees on a project- and site- specific basis.

Mitigation measures should seek to address both direct and indirect impacts on the species and its supporting habitat. Killarney fern is particularly sensitive to changes in micro-habitat conditions including humidity, shading, light levels and exposure to the wind. Similarly, any changes to the hydrological regime within habitats which support this species could have a detrimental effect on populations. Killarney fern is also vulnerable to air and water pollution.

Given the precise requirements of this fern and its sensitivity to desiccation, the translocation of individual mature specimens or communities should be seen very much as a last resort, since finding a suitable receptor site with appropriate ecological, hydrological, soil and shade characteristics is likely to be problematic. The propagation of this plant requires specialist horticultural techniques.

Key reference

- Rumsey, F.J. et al, 1999. Population structure and conservation biology of the endangered fern *Trichomanes speciosum* Willd. (Hymenophyllaceae) at its northern distributional limit. *Biological Journal of the Linnean Society* (3), p. 333-344.
- Kingston, N. & Hayes, C., 2005. The ecology and conservation of the gametophyte generation of the Killarney Fern (*Trichomanes speciosum* Willd.) in Ireland. *Biology and Environment: Proceedings of the Royal Irish Academy* 105B(2), p. 71-79.
- NPWS, 2007. *Conservation Assessment of Killarney Fern (Trichomanes speciosum Willd.) in Ireland. Conservation Status Assessment Report*. Dublin: National Parks and Wildlife Service.
- NPWS, 2008. *All Ireland Species Action Plan Killarney Fern*. Northern Ireland and Republic of Ireland: Environment and Heritage Service; National Parks and Wildlife Service.

KEY CARD: SEDGES AND GRASSES

Slender Cottongrass (*Eriophorum gracile*)

Slender Cotton Grass (*Eriophorum Gracile*) Photo: Josef Hlasek

Description

Slender cottongrass is a creeping perennial sedge with slightly folded leaves and a small group of drooping flower-spikes with white, cottony bristles. Like all cottongrasses, it is very conspicuous when in fruit, but easily overlooked when in its vegetative state. It grows 20-60cm tall and has a three-angled stem throughout its length, with narrow (1-2mm), short, blunt leaves, and shorter spikelets than common cottongrass. It is distinguishable from other cottongrasses by its several-veined glumes and rough spikelet stalks with short bristly hairs.

Flowering Period

This species flowers between June and August.

Habitat Preferences

Slender cottongrass occurs in wet bogs and around lake margins. It is associated with sites that are calcareous or moderately acidic, and which have some water movement. The species is thought to be restricted in distribution to west Galway and it is considered very rare.

Survey Techniques

Where areas of suitable habitat have been identified within the route corridor, targeted searches should be carried out to confirm presence or absence of this species. If presence is confirmed, further surveys should be undertaken to establish the size of the population, and the distribution of the species should be mapped. GPS and GIS mapping of the locations of individuals and groups of important sedge and grass species can subsequently be invaluable to both mitigation and monitoring. The methods outlined in the '*Species-specific survey*' section of the GSGN for habitats, plants and fungi apply to slender cottongrass.

Optimum Survey Period

Surveys for slender cottongrass should be conducted between June and August, when the species is in flower and therefore most conspicuous in the field.

Mitigation, compensation and enhancement

The principles outlined in the '*Mitigation, compensation and enhancement*' section of the GSGN for habitats, plants and fungi apply to slender cottongrass. Effective mitigation, compensation and enhancement measures should be designed in consultation with the NPWS and other relevant consultees on a project- and site-specific basis. However, the following represent key considerations:

Avoidance of impacts on habitats suitable for slender cottongrass should form the principal mitigation measure. Where this cannot be achieved, habitat losses may be minimised through sensitive route alignment, avoiding key areas of importance within wider bog and wetland habitat assemblages.

Impacts associated with road projects on habitat suitable for slender cottongrass may be both direct and indirect. Like many species associated with bogs, slender cottongrass is especially sensitive to changes in the hydrological regime. Water pollution (including diffuse pollution) and changes in nutrient balance also constitute potential impacts requiring consideration. In each case, the likely geographical extent of each impact should be determined and the results used to design appropriate mitigation strategies.

Slender cottongrass is associated with liquid peat and the conditions in which it grows would make any attempts at translocation problematic, both in terms of moving the plant from its original location and recreating the conditions that it requires at the receptor site. However, where it is not possible to avoid direct or indirect impacts on this species, it to may be appropriate to compensate for habitat loss through translocation of areas of peat bog lost beneath the footprint of the road project to extend and/or enhance adjacent areas of degraded bog. Detailed soil and hydrological assessments and design would, however, be critical to the success of such projects.

Meadow Barley

(*Hordeum secalinum*)

Description

Meadow barley is a short perennial between 20 and 80cm in height. Its leaf blades are rough and flattened, measuring 2-15cm in length and 2-6mm in width. It has a somewhat flattened spike, which is purple-flushed, with erect spikelets with bristle-like glumes.

Meadow Barley
(*Hordeum secalinum*)
Photo: Mike Dodd

Flowering Period

This species flowers between June and July.

Habitat Preferences

Meadow barley occurs in damp, coastal and inland grasslands and meadows. Its distribution is limited to the east and south-east of Ireland and it is considered to be rare.

Survey Techniques

The methods outlined in the '*Species-specific survey'* section of the GSGN for habitats, plants and fungi and those detailed for slender cottongrass above also apply to meadow barley.

Optimum Survey Period

Surveys for meadow barley should be conducted between June and July, when the species is in flower and therefore most conspicuous in the field.

Mitigation Measures

Wherever possible, direct and indirect impacts on meadow barley, along with habitats which support this species, should be avoided. Opportunities for the enhancement of existing habitat should be sought where these arise. In each case, effective mitigation, compensation and enhancement measures should be designed in consultation with the NPWS and other relevant consultees on a project- and site-specific basis. Where impacts cannot be avoided, habitat losses should be minimised through sensitive route alignment, avoiding key areas of importance within wider habitat assemblages. Further measures may include fencing-off of key habitats during construction phase activities. Where disturbance cannot be avoided, appropriate compensation and enhancement should be provided by habitat restoration and creation schemes. Where habitat suitable for meadow barley would unavoidably be lost beneath the footprint of the road project, translocation of turves to specially selected receptor sites should form part of the mitigation

measures.

Key reference

- Curtis, T.G.F., McGough, H.N., 1988. *The Irish red data book. 1. Vascular plants. Wildlife Series Ireland*. Dublin: Stationary Office.
- Rose, F., 1989. *Grasses, sedges, rushes and ferns of the British Isles and North-western Europe*. London: Viking Penguin Group.

KEY CARD:
Marsh Saxifrage
(*Saxifraga hirculus*)

Description

A perennial plant with a solitary yellow flower on the tips of the tufted stems, marsh saxifrage (also known as yellow marsh saxifrage) is generally 6-20cm tall. The leaves are hairless, but the stem has curly reddish hairs. Each stem has five separate, spreading-to-reflexed sepals that are 3-5 mm long, with spreading hairs on the margin, and five yellow, narrowly elliptic, petals that are 7-13 mm long. Marsh saxifrages reproduce readily via vegetative propagation in suitable circumstances, especially around springs.

Marsh Saxifrage
(*Saxifraga hirculus*)
Photo: Niall Lockhart, NPWS

The species is declining or threatened in most European countries due to loss of suitable habitat. Afforestation, improvement of marginal agricultural land by drainage, and increases in grazing pressure on habitats supporting marsh saxifrage are the principal causes of habitat loss.

Flowering Period

This species flowers between mid-July and October.

Habitat Preferences

Marsh saxifrage occurs in wet bogs, base-rich flushes, fens and mires. It is now considered an upland species because its favoured habitats in the lowlands have been destroyed. In Ireland, the species has suffered from both overgrazing and drainage. Although moderate levels of grazing are probably beneficial to marsh saxifrage, many of the sites for the species are heavily grazed. Records indicate that the distribution of this species is now limited to Co. Mayo.

Surveying Techniques

Where areas of suitable habitat have been identified within the route corridor, targeted searches should be carried out to confirm presence or absence of this species. If presence is confirmed, further surveys should be undertaken to establish the size of the population, and the distribution of the species should be mapped. GPS and GIS mapping of the locations of important plant species can subsequently be invaluable to both mitigation and monitoring. The methods outlined in the '*Species-specific survey*' section of the GSGN for habitats, plants and fungi apply in respect of marsh saxifrage.

Optimum Survey Period

Surveys for marsh saxifrage should be undertaken during the flowering period between August and September, when individuals are most easily observed and identified.

Mitigation, compensation and enhancement

The principles outlined in the '*Mitigation, compensation and enhancement*' section of the GSGN for habitats, plants and fungi also apply to marsh saxifrage. Effective mitigation, compensation and enhancement measures should be designed in consultation with the NPWS and other relevant consultees on a project- and site-specific basis. However, the following represent key considerations.

Given the highly restricted status and distribution of the species in Ireland, avoidance of impacts upon habitats suitable for marsh saxifrage should form the principal mitigation measure. Where this cannot be achieved, habitat losses should be minimised through sensitive revisions to route alignments that avoid key areas of importance within the supporting habitat assemblages.

Being a wetland species, marsh saxifrage is particularly sensitive to changes in hydrology and nutrient balance. Appropriate measures should therefore be taken to protect the hydrological regime and water quality, including comprehensive pollution protection procedures both during and post-construction. A hydrological assessment should be carried out to ensure that site clearance and earthworks activities do not lead to changes in the local drainage characteristics with consequent impacts on habitats supporting marsh saxifrage.

Availability of suitable receptor sites represents the greatest constraint to the use of translocation as a mitigation technique. Replicating and maintaining the required soil, hydrological, nutrient and grazing conditions at the receptor site will be critical to the success of any translocation project, requiring a suite of detailed assessments across each of these categories. Where areas of habitat suitable for marsh saxifrage would unavoidably be lost beneath the footprint of the road project, works to extend and/or enhance adjacent areas of degraded habitat should form a key part of the mitigation and compensation programme.

Key reference

- National Parks and Wildlife Service, 2007. *Conservation Assessment of Saxifraga hirculus in Ireland*. Dublin: National Parks and Wildlife Service.
- Curtis, T.G.F., McGough, H.N., 1988. *The Irish red data book. 1. Vascular plants. Wildlife Series Ireland*. Dublin: Stationary Office.
- Preston, C.D., Pearman, D.A. & Dines, T.D., 2002. *New Atlas of the British & Irish Flora*. Oxford: Oxford University Press.

KEY CARD:
ORCHIDS
Irish lady's-tresses (*Spiranthes romanzoffiana*)

Irish Lady's-tresses (*Spiranthes romanzoffiana*)
Photo: Paul Hackney

Description

The Irish lady's-tresses orchid (also known as drooping lady's-tresses) has sheathing yellowish-green leaves. It grows to between 10 and 30 centimetres in height. The flowers are large and creamy-white in colour with green markings. They are sessile and are arranged in three close spirals. There is no standardised census of populations for this species in Ireland, but population losses have been recorded in important populations in the Lough Neagh basin and the south-east. Changing management practices are thought to be partially responsible for the species' decline, but awareness is hampered by a paucity of ecological information relating to the species. Grazing is a critical factor in the endurance of this orchid, with both over- and under-grazing bringing about declines, and the seasonality of livestock grazing regimes, together with the effects of grazing by other species may exert an influence on plant reproduction and survival.

Flowering Period

New lateral buds are produced in the summer months and develop slowly through the autumn and winter months, to produce medium-sized plants in spring and full-sized plants in summer. The flowering period is early-August to early-September. As with most orchids, the Irish lady's-tresses tubers can lie dormant underground for much of the year (and for several years at a time). As a result there may be little or no above ground plant material.

Habitat Preferences

Irish lady's-tresses occurs in damp meadows, along the shores of lakes and rivers, in seasonally flooded meadows, and in valley bogs. This species has very specific microhabitat requirements due to a mutualistic association between soil fungi (mycorrhizae) and plant roots. Populations have been located in the western and northern counties of the Republic of Ireland, and despite declines, new populations continue to be discovered, with sites identified in Co. Galway and Co. Mayo since 2000. A number of sites have previously been recorded across Counties Cork, Kerry and Donegal, with a western cluster around Loughs Conn, Cullin, Corrib, Allen and Mask.

Survey Techniques

Where areas of suitable habitat have been identified within the route corridor, targeted searches should be carried out to confirm presence or absence of this species. If presence is confirmed, further surveys should be undertaken to establish the size of the population, and the distribution of the species should be mapped. GPS and GIS mapping of the locations of important plant species can subsequently be invaluable to both mitigation and monitoring.

The methods outlined in the '*Species-specific survey'* section of the GSGN for habitats, plants and fungi apply in respect of Irish lady's tresses. However, since the species may lie dormant (as a below-ground tuber) in a single survey year, it may be necessary to adopt a precautionary approach, relying on desk study information as far as possible. Detailed consultation with NPWS and/or other relevant consultees is advised in all situations where road projects affect areas of potential habitat, in order to determine an appropriate level of survey effort.

Optimum Survey Period

Surveys for Irish lady's tresses are seasonally constrained, being limited to the flowering period between early-August and early-September. Outside of these periods, individuals may be impossible to identify, or entirely absent above the ground.

Narrow-leaved helleborine (*Cephalanthera longifolia*)

Description

This orchid can reach up to 60 cm in height, though in exposed locations height is reduced. It has long, pointed leaves and up to 40 white flower heads arranged spirally. Collecting of specimens and cessation of woodland management are thought to have contributed to this species' decline in the 19th and 20th centuries.

Narrow-leaved Helleborine (*Cephalanthera longifolia*) Photo: Laurie Campbell

Flowering Period

Narrow-leaved helleborine flowers in Ireland between May and the first week in July.

Habitat Preferences

This species grows in well-lit areas, and has been recorded growing between cracks in limestone pavement and in exposed conditions on calcareous sand which is overlying peat. It has been recorded in Counties Mayo and Clare, with populations occurring in parts of the Burren.

Survey Techniques

Where areas of suitable habitat have been identified within the route corridor, targeted searches should be carried out to confirm presence or absence of this species. If presence is confirmed, further surveys should be undertaken to establish the size of the population, and the distribution of the species should be mapped. GPS and GIS mapping of the locations of important plant species can subsequently be invaluable to both mitigation and monitoring.

Optimum Survey Period

Surveys for Narrow-leaved helleborine are seasonally constrained, being limited to the flowering period between May and the first week in July. During this time, individuals can be readily identified in the field.

Mitigation, compensation and enhancement (both species)

The principles outlined in the '*Mitigation*' section of the GSGN for habitats, plants and fungi apply to both Irish lady's tresses and narrow-leaved helleborine. Effective mitigation, compensation and enhancement measures should be designed in consultation with the NPWS on a project- and site-

specific basis. However, the following represent key considerations:

Given the highly restricted status and distribution of these species in Ireland, avoidance of impacts upon habitats suitable for either Irish lady's-tresses or narrow-leaved helleborine should form the principal mitigation measure. Where this cannot be achieved, habitat losses should be minimised through sensitive alterations to route alignment which avoid key areas of importance within the supporting habitat assemblages.

Where disturbance cannot be avoided, attempts should be made to 'rescue' the plant by translocating macro-turfs to a suitable, specially prepared receptor site. It should be noted however, that the translocation method for orchids is complicated by the specific requirements for soil fungi (mycorrhizae). The fungus is essential for reproduction, and where translocation is considered, the receptor site must also support suitable conditions, including light, moisture and temperature. Any seeds that are collected and subsequently sown must be infected with the mycorrhizal soil fungus. Consequently any translocation project is likely to require the involvement of a specialist nursery to ensure that any translocated plants and plants raised from seeds survive to maturity, with propagation techniques employed to supplement a macro-turfing exercise. Where translocation has taken place, after-care would be essential, including watering, monitoring and careful management.

Key reference

- Curtis, T.G.F., McGough, H.N., 1988. *The Irish red data book. 1. Vascular plants. Wildlife Series Ireland*. Dublin: Stationary Office.
- Lang D., 2004. *Britain's Orchids*. Hampshire: Wildguides Ltd.
- NPWS, 2005. *All Ireland Species Action Plans*: *Irish lady's-tresses*. Northern Ireland and the Republic of Ireland: National Parks and Wildlife Service; Department of the Environment, Heritage and Local Government; Environment Heritage Service, Department of the Environment Northern Ireland.
- Preston, C.D., Pearman, D.A. & Dines, T.D., 2002. *New Atlas of the British & Irish Flora*. Oxford: Oxford University Press

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TERRESTRIAL INVERTEBRATES GROUP-SPECIFIC GUIDANCE NOTE

Group-specific Guidance Note: Terrestrial Invertebrates

GENERAL CHARACTERISTICS OF THE GROUP

The term 'invertebrates' refers to all animal species without a backbone. The majority of terrestrial invertebrates are insects, but the group also includes spiders, snails and slugs, woodlice, centipedes and millipedes, earthworms and a number of other, more obscure groups.

Invertebrates are extremely diverse and adaptable, and can be found occupying virtually any niche (or microhabitat), although species of conservation concern are generally not found in the most common and widespread habitats. Given the highly diverse nature of the group, it is difficult to give generic advice as to which habitats or features are of greatest importance to invertebrates. However, in general, it is long-established, structurally-diverse and plant-rich unimproved habitats (such as native woodlands or species-rich unimproved grasslands) that tend to support the rarer species and the most diverse assemblages of terrestrial invertebrates. Habitat 'mosaics' also tend to be particularly important (whether within woodland, grasslands, wetlands, etc.), especially where there is a varied substrate and topography, and a wide variety of valuable sub-habitats, such as dead-wood, standing water, and bare ground.

Despite this emphasis on habitat diversity, a significant proportion of the rarer terrestrial invertebrate species are associated with relatively species-poor, homogeneous habitats, such as heathland or reedbed, as the more extreme conditions experienced in these habitats often require a higher degree of specialisation. Thus, species such as Geyer's Whorl Snail are very limited in their distribution, being adapted to a highly restricted set of habitat parameters (in this case, constantly humid calcareous flush-fens that are fed by tufa-depositing springs).

Many of the larger areas of the NRA's roadside landscapes, most notably areas of bog/heathland, woodland and south-facing cuttings with a short, species-rich grass sward, are therefore likely to be of some importance for invertebrates. It is important to recognize, that the management of road landscapes to provide a wide range of botanically-diverse habitats will lead to high invertebrate biodiversity in these areas.

POTENTIAL IMPACTS OF ROAD PROJECTS

There are several aspects of road construction and operation that can have adverse impacts on important terrestrial invertebrate species; these include habitat loss and degradation (generally through site clearance activities), fragmentation of habitat (road corridors often form a significant physical barrier to dispersal and to the re-colonisation process for invertebrates), and direct mortality of individuals (both during site clearance and during the operational phase of a road project).

Conversely, both new road projects and the management of the existing road landscapes also present considerable opportunities to enhance and protect habitats for certain invertebrate species, in particular through habitat enhancement and appropriate management (especially through modifications to routine maintenance in order to create mosaics of valuable habitat).

SURVEY TECHNIQUES

It is important to recognise that general surveys for terrestrial invertebrates are only likely to be required should the desk study and/or an assessment of the habitats within the route corridor during the multi-disciplinary walkover survey reveal that important assemblages are likely to be present. A combination of a desk study and an initial analysis of the habitats will therefore be necessary to help determine whether more detailed surveys are needed, and if so, the survey methodologies that may be required. Any requirement for individual target species surveys (e.g. for Kerry slug or Marsh fritillary butterfly) will also be 'triggered' in this way, and methodologies for these species are presented separately on Key Cards.

A large number of survey techniques are available for collecting terrestrial invertebrates. The most commonly used are: pitfall trapping (for ground-dwelling species); sweep netting and beating trays (for species on vegetation); Malaise traps and flight interception traps (for flying species); light trapping (for moths); dry extraction techniques (for species in leaf litter, dung, bark etc.); butterfly transects and other direct observation surveys (e.g. for dragonflies and damselflies); and hand searching (of microhabitats, such as rotten logs, moss etc.). A combination of these techniques will be required if the aim is to achieve a relatively comprehensive species list for a particular site.

Any survey for invertebrates should be sufficiently thorough to inform an appropriate level of impact assessment, without being unnecessarily costly or time-consuming.

This can either involve the employment of trained, experienced entomologists to carry out targeted field assessments (based on their extensive knowledge), of particular sites or habitat features identified during the multi-disciplinary walkover survey; or using more generalist ecologists to collect samples for subsequent analysis and identification (generally by a lab-based taxonomist), but again, focussing on target sites and habitat features that have already been highlighted as working of this level of survey. Either way, an appropriate level of expertise will be required to undertake the assessment as a good understanding of the importance of different species is essential if the significance of any impacts is to be adequately assessed.

Surveys for terrestrial invertebrates should ideally be carried out on at least three separate occasions between April and September, in order to sample species that emerge at different times over the summer. Targeted surveys for particular species will need to focus more specifically on the known flight period or activity 'window' for that particular species, and this is addressed in more detail on the species-specific Key Cards.

Mitigation, compensation, enhancement

Should road-related development or maintenance works result in an unavoidable and likely significant impact on a population of rare invertebrates, or a particularly diverse assemblage, it will be necessary to devise an appropriate mitigation strategy, usually in consultation with the NPWS and/ or other relevant consultees. This will preferably comprise avoidance of the key habitat areas, if at all possible, but may also involve seasonal constraints on works, the minimisation of indirect effects (such as protecting the hydrology of adjacent boggy areas), or

even the translocation of individual animals (although this is not normally appropriate for invertebrates). If it has not been possible to confirm the absence of an important invertebrate species during the assessment process, and the site lies within the appropriate geographical range for that invertebrate and the habitat is suitable, a precautionary approach to mitigation should be adopted.

The mitigation measures should be proportionate to the importance of the invertebrate population that would be affected and the scale of the potential impacts upon them. Furthermore, a suitably experienced ecologist should be present on site to supervise the mitigation, and to monitor the works to ensure that retained important invertebrate habitats are protected.

In addition to minimising adverse effects on invertebrates, opportunities to enhance the value of road landscapes for invertebrates should also be adopted, wherever possible, not only on new road projects but also through improvement to routine maintenance/management works. This could include, for example, habitat enhancement and targeted management activities (such as appropriate mowing regimes and scrub control), and should be undertaken wherever possible to achieve specific nature conservation objectives, preferably in consultation with the NPWS and other relevant consultees.

KEY CARD:

Marsh Snails (*Vertigo* spp.)

Description

The three marsh snails addressed in this Key Card, the narrow-mouthed whorl snail (*Vertigo angustior*), Geyer's whorl snail (*Vertigo geyeri*) and Desmoulin's whorl snail (*Vertigo moulinsiana*), are members of the Vertiginidae family. Along with the other five species of whorl snail found in Ireland, they are amongst the smallest of the country's land molluscs, ranging in size from 1.7 to 2.2mm in height and 1 to 1.5mm in width. The whorl snails have peculiar outgrowths called 'teeth' in the aperture, designed to prevent predators from entering the shell and killing the animal.

Geyer's whorl snail (*Vertigo geyeri*)

Desmoulin's whorl snail (*Vertigo moulinsiana*)
Photos: Roger Key

The narrow-mouthed whorl snail is one of two species of whorl snail in which the shell is sinistrally coiled (the mouth is on the left when viewed from the front). It has a reddish-coloured shell covered with fine vertical striations. Its present range in Ireland comprises the western seaboard of Ireland from west Cork to North Donegal, with additional inland sites in the south east.

Geyer's whorl snail has a pale reddish-brown conical shell with regular growth-lines. In Ireland, it has been recorded from sites in the Midlands and the North-west.

Desmoulin's whorl snail is the largest of the whorl snails which inhabit Ireland, with a height of 2.2 to 2.7mm, and there are no regular striations on the upper whorl of the shell. It has mostly been recorded from sites in the Midlands and the Shannon Basin from Lough Derg to Longford, and in outlying sites from Kerry to Wicklow.

Life-Cycle and Behaviour

Most members of the *Vertigo* genus are believed to feed on micro-fungi growing on dead and decaying plant remains. All three species are hermaphrodite and capable of self-fertilising, and both the narrow-mouthed whorl snail and Desmoulin's whorl snail frequently do. Across all three species, the main reproductive period varies between sites, and with meteorological conditions. At most sites, however, this appears to be between March and April for the narrow-mouthed whorl snail and Geyer's whorl snail, and in the summer for Desmoulin's whorl snail. Eggs develop within a fortnight for all three species and sexual maturity is reached within one year. Individuals generally live for between one and two years. In the case of both the narrow-mouthed whorl snail and Geyer's whorl snail, adult numbers reach a maximum in the autumn.

The narrow-mouthed whorl snail can reach particularly high population densities in maritime situations. Within one year, it can be dispersed over distances of up to 100 metres, via a number of mechanisms including movement by slugs and small mammals, and in wind-blown litter. Geyer's whorl snail frequently occurs at low population densities, and populations with no clear annual cycle have also been recorded. Mechanisms of dispersal are uncertain, but may include movement by birds and grazing animals. Desmoulin's whorl snail population densities exhibit considerable annual fluctuation. Large numbers of juveniles of this species are recorded in the autumn. The principal mechanism of dispersal for Desmoulin's whorl snail is thought to be water-borne transportation during periods of flooding. Mammals and birds may also act as dispersal vectors.

Habitat Preferences

The narrow-mouthed whorl snail occurs in a variety of habitat categories, including grassland, fen, marsh, salt marsh and flood plain. In Ireland, the snail is found associated with decaying vegetation in the litter layer, or in damp moss in open un-shaded habitats. For the most part the snail can be found in open-structured, humid litter, although in very wet conditions it can climb 10-15cm up plant stems or onto damp decaying timber. It can also be found below the litter layer in the soil in dry conditions. The snail can be found at the base of tussocks in grassland habitats, or among moss patches at the edge of dune slacks in fixed dune grassland. It may also be found among flood debris. Owing to its specific microhabitat requirements, the species is often restricted to narrow zones around wetlands, often only a few metres wide. These display high, even humidity, with flowing groundwater, but are not subject to deep or prolonged flooding or to periodic desiccation.

Geyer's whorl snail is a rare alpine snail found in saturated water conditions in calcareous flush-fens that are fed by tufa-depositing springs. These flushes may only be a few square metres in extent, and often exist as mosaics of suitable patches within wider fen macro-habitats. In Ireland, these can occur within a range of broad habitat types, including raised bog laggs, transition mires, lake shores, slopes, and wetlands associated with coastal dunes and machair. Within these habitats, the snail occurs within the saturated and decaying roots of small sedges (*Carex* spp.) and associated fen mosses (especially *Drepanocladus revolvens* and *Campylium stellatum*). It requires an open habitat that prevents succession by shade-loving plants and competition from shade-loving snails.

Desmoulin's Whorl Snail generally inhabits calcareous, lowland wetlands, occurring in swamps, fens and marshes often bordered by water. High humidity appears to be important in determining local distribution within sites. The snails can be found on living and dead stems and leaves of tall plants including sedges (*Carex* spp.), Saw-sedge (*Cladium mariscus*), Reed-grass (*Glyceria maxima*) and Reeds (*Phragmites australis*) and a wide variety of other emergent waterside vegetation. They climb this vegetation in the summer and autumn months, and descend into the leaf litter in winter. They also can shelter for long periods on the lower leaves of plants in severe (i.e. very dry) conditions. This species requires a stable hydrology, where the water table is predominantly at the same level, or just exceeds, the ground surface, and seasonal flooding is limited.

Survey Techniques

Detailed survey methodologies should be designed on a project- and site-specific basis in consultation with the NPWS. For Desmoulin's whorl snail, which lives on stems and leaves of plants in summer

months, the most appropriate method is likely to comprise a combination of standardised hand-searching and the beating technique (see below), to maximise survey efficiency. Micro-habitats and vegetation preferred by this species (described above) should be assessed as a priority. If individuals are found in these habitats, the survey can be extended to include less suitable habitats and plant species.

Relevé (Quadrat) searches may be used to delineate small areas of ground vegetation for intensive hand-searching of plant stems, the litter layer and roots. If the hand-search does not reveal presence of this species, the beating technique should be employed: a plastic sheet (or beating tray) is laid on the ground at the base of a measured strip of vegetation, which is bent over the sheet or tray and vigorously shaken and beaten to release the adhering snails.

Depending on the experience of the surveyor, it may be possible to identify whorl snail species in the field, using appropriate magnification. However, it is recommended that a number of samples be collected for processing by specialists under laboratory conditions to verify results. Additional information (such as weather conditions) should also be recorded to identify any constraints encountered during the sampling and thus determine the relative efficiency of the survey.

For the narrow-mouthed whorl snail and Geyer's whorl snail, which tend to be found in the litter layer and amongst roots of sedges, a more appropriate method is to combine hand-searching with a technique in which a sample of the microhabitat (e.g. leaf litter or moss) is removed and taken to a laboratory where it is air-dried and sieved through a series of different mesh sizes. Molluscan shells can then be removed and identified under a microscope. This method has the advantage of including empty shells in the sample.

Optimum Survey Period

The optimum period for detecting the narrow-mouthed whorl snail and Geyer's whorl snail is likely to be during the main reproductive period, believed to be between March and April, whilst for Desmoulin's whorl snail it will be summer months, when peak numbers of adults are active. Surveys should not be undertaken during windy conditions when snails may seek shelter. Similarly, in wet conditions snails may be more difficult to release from vegetation or crawl lower down the leaves, and the seeds and plant litter may coagulate.

Since population numbers of marsh snails fluctuate naturally with season and environmental conditions, more limited repeat inspections will be more effective than a single intensive survey. Population size is likely to be higher during wet, humid summers and lower in periods of drought, and surveys should be avoided during the latter. The number of repeat inspections necessary at a given site should be reviewed with the NPWS and other relevant consultees.

Mitigation Compensation and Enhancement

Effective mitigation should be designed on a site- and project- specific basis, however a number of general principles apply. The most important mitigation measure is avoidance or minimising the loss of suitable habitat through sensitive route alignment. Marsh snails are particularly sensitive to changes in hydrology and eutrophication (i.e. increases in nutrient status of the water), and appropriate measures should therefore be taken to protect the hydrological regime and water quality of the relevant

wetland features, including especially stringent pollution protection procedures both during and post construction. A hydrological assessment should be carried out to ensure that site clearance and earthworks activities do not lead to changes in the local drainage characteristics with consequent impacts on the snails. Scrub encroachment should also be prevented to avoid habitat alteration.

If direct impacts on marsh snails cannot be avoided, it will be necessary to undertake a site-specific review with NPWS and other relevant consultees to determine appropriate mitigation and/or compensation. Strategies are likely to involve erecting protective fencing around areas in which marsh snails are known to occur to protect the animals and their habitat from harm during road construction and maintenance activities. Given the precise habitat requirements of these species, habitat re-creation is likely to be difficult to achieve. Habitat enhancement measures may be the preferred option to help conserve existing populations, and are likely to involve the use of appropriate livestock for grazing at controlled intensities (e.g. cattle in narrow-mouthed whorl snail habitat, sheep in Geyer's whorl snail habitat) and the fencing-off of habitat areas to reduce trampling damage. Translocation of individuals should be seen as a last resort, as its success cannot be guaranteed.

Given the short life-span of these species, post-construction monitoring should comprise frequent, rapid surveys to detect any declines in population sizes in order to instigate remedial action before they are lost.

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Key Card:
Kerry Slug
(*Geomalacus maculosus*)

Kerry Slug (*Geomalacus maculosus*)
Photos: Paul Scott, Scott Cawley

Description

The Kerry slug is a member of the Arionidae family. It is marked with white or yellow spots, and two colour forms exist: a blue/grey slug with white spots; and a ginger or brown form with yellow spots. Both varieties co-exist in Ireland. Adults can appear up to 70 to 80mm long, but may contract into a ball shape when disturbed, unlike any other Irish slug. They are also able to elongate and flatten themselves to take refuge in crevices.

The Kerry slug has a very restricted global range, occurring only in Ireland, Spain and Portugal (where it is possibly now extinct). In Ireland it is a member of the distinct faunal and floral element known as 'Lusitanian' species.

Life-Cycle and Behaviour

Kerry slugs feed on lichens, liverworts and mosses growing on rocky outcrops and on mature trees and timber. They are active at night throughout most of the year if it is not too cold or dry, and also commonly during the day, emerging to feed in very damp and humid conditions on cloudy, warm, damp days, either during or after rain. At other times they hide in crevices, under dead bark and stones.

Kerry slugs are capable of self-fertilisation and produce eggs in batches of 18 to 30 between July and October. The eggs are large, approximately 6 to 8.5mm by 3 to 4.25mm, and take between six and eight weeks to hatch. The animals can live for up to seven years, becoming sexually mature in their second year.

Habitat Preferences

In Ireland, the Kerry slug is restricted to the sandstone geology of west Cork and Kerry, where it has been recorded from fifty 10km squares since 1965. Within this range, it occurs within two broad habitat types.

The first habitat type is oak-dominated or mixed deciduous woodland with a mixture of oak and birch. Woodland on slopes which incorporate rocky outcrops or scattered boulders is of particular value. Other favoured conditions include: areas where trees and rock are situated close to water in undisturbed, humid conditions; areas with clean air; and areas with a good lichen, or lichen, liverwort and moss floras. In this habitat, the slugs can graze the organic film of the lichen and associated flora.

The second broad habitat type includes areas of unimproved oligotrophic open moor or blanket bog, with sandstone outcrops and boulders. These areas may be largely devoid of vegetation except for lichens and mosses, which are present in a sufficiently large quantity to provide enough suitable grazing material.

Survey Techniques

It will obviously only be necessary to consider the need to undertake specific surveys for Kerry slug within its geographical range. Should the multi-disciplinary walkover survey and desk study identify habitats suitable for use by this species that could be affected by the proposals, then targeted surveys would be necessary.

It is recommended that fixed-route transects should be walked at 20m intervals throughout oak woodland or bog habitat at night using torchlight, and a visual count made of the number of individuals observed within five metres of the transect. This will involve a careful search of features on which the animals are likely to be feeding, especially tree trunks, moss-covered timber close to water, and lichen covered boulders and outcrops. Transects should be covered over a fixed time period to provide indices of relative abundance and allow comparison between sites in those situations where such data would be useful.

Optimum Survey Period

Surveys for the Kerry slug can be carried out all year round. Assuming there are no significant health and safety implications, they should be conducted at night, particularly during damp and humid conditions. Periods of excessive cold or drought should be avoided as survey efficiency during these periods is considerably reduced. Whilst surveys can be carried out on cloudy, damp days, the efficiency of these searches will be lower than for nocturnal surveys.

Mitigation, compensation and enhancement

Given that mitigation is likely to be site-specific in nature, detailed mitigation strategies should be developed in consultation with the NPWS and other relevant consultees. In the first instance, areas with known populations of the Kerry slug in the sandstone geology of west Cork and Kerry should be avoided through route selection. Where loss of suitable habitat cannot be avoided through alterations to route alignment, measures should be taken to protect populations. Appropriate measures are likely to involve erecting protective fencing around areas in which the Kerry slug is known to occur to protect the animal and its habitat from harm during road construction and maintenance activities. Translocation and habitat enhancement schemes should be avoided wherever possible, since the Kerry slug is particularly vulnerable to changes in its habitat.

In all cases, impact assessment should consider the likely effects of atmospheric pollution, to which lichens (the main food source of the Kerry slug) are particularly sensitive. In addition, care should be taken to ensure there is no increase in the spread of exotic species such as rhododendron, since this invasive species changes the humidity regime of woodland and open habitats that it invades, making them less suitable for the Kerry slug.

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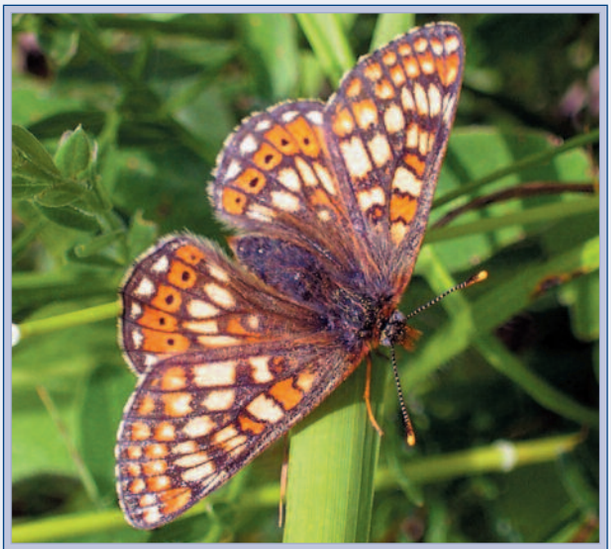
KEY CARD:

Marsh Fritillary

(*Euphydryas aurinia*)

Description

This butterfly has reticulate black, orange and yellow wing markings. Larvae of the marsh fritillary are dark in colour, and are generally found in large groups basking on silk webs amongst the leaves of Devil's-bit Scabious (*Succisa pratensis*), the larval food plant. Populations of marsh fritillary are often fragmented into semi-isolated meta-populations.



Marsh Fritillary
(*Euphydryas aurinia*)
Photo: Cresswell Associates

Life-Cycle and Behaviour

The adults are active between early- to mid-May and the end of June or early-July. Females lay their eggs in neat contiguous groups of up to 350 on the underside of devil's-bit scabious leaves around late-June. Smaller second and third batches of eggs may follow. The larvae are between 25 and 30mm long, and have a uniformly black body, head and short, branched spines. The body has a speckling of white dots.

The size of marsh fritillary populations vary greatly from year to year, mainly due to climatic factors and to cycles of attack from parasitic wasps. Adults of the species are generally sedentary, remaining in a series of linked meta-populations, forming numerous temporary sub-populations which can often die out but subsequently become recolonised from adjacent sites. Where unable to do this, populations do not seem to be able to persist in habitat fragments.

Habitat Preferences

The marsh fritillary is considered to be one of the most endangered species in Ireland. In common with other rare butterfly species, the species is restricted to a narrow ecological niche defined by the combination of occurrence of adequate quantities of the larval food plant alongside specific microhabitat features. The marsh fritillary can be found in wet grassland and very locally in fixed dunes, machair, fen, and bog habitats. The presence and distribution of marsh fritillary butterflies within these habitat types is largely determined by the abundance and distribution of Devil's-bit Scabious in a mixed sward of varying height, often largely dominated by Purple Moor-grass (*Molinia caerulea*). The species also requires open areas where, in the spring, larvae can receive sunlight close to ground level. Most colonies occur on unimproved damp grassland, but some colonies, especially in north-west Ireland, occur on coastal sites, in sand dunes or on dry calcareous grassland, while a few occur on eskers.

Survey Techniques

Following the desk study and the multi-disciplinary walkover survey, targeted surveys for the marsh fritillary will generally only be required if there are existing desk study records for the locality and if the habitat with which they are likely to be associated would be affected by the proposals (see below). Specific surveys may also be appropriate if, in the absence of existing records, areas of particularly suitable habitat are identified. Where records exist, surveys should focus on suitable patches of habitat within the vicinity of the known record. Should they be deemed necessary, a suite of surveys will usually be required, comprising a more detailed habitat suitability assessment, combined with surveys for adults (in May/June) and larvae (in August/September).

The extent of the area to be surveyed should be based primarily upon the zone of influence over which impacts associated with the road construction and operation are anticipated, including remote hydrological effects on the damp habitats on which the species tends to depend. In addition, since the linear nature of road developments may result in significant habitat fragmentation effects, consideration should also be given to the distances over which the species can disperse and colonise and any possible 'barrier' effects that might arise during and after construction. Furthermore, due to the sometimes ephemeral nature of their sub-populations, their absence from otherwise suitable sites in the vicinity of existing populations in a given year cannot rule-out the use of the area in subsequent seasons. As such, suitable but currently unoccupied habitat near to existing populations should also be considered of value, as these habitats may be critical to the long-term survival of the population.

Optimum Survey Period

Adult Surveys: The optimum period for detection of the adult butterflies is late-May and the first half of June. Males are very active on the wing in sunny conditions in late-morning and early-afternoon, flying constantly in search of females, and stopping frequently to take nectar, usually from Meadow Thistle (*Cirsium dissectum*), but also Tormentil (*Potentilla erecta*), buttercup (*Ranunculus* spp.), Hawkbit (*Leontodon* spp.) and Milkwort (*Polygala* spp.). In overcast weather, butterflies of both sexes perch for long periods on low foliage, or in rabbit-scrapes or other depressions.

Larval Surveys: The optimum survey period for larvae is during August and September, in sunny conditions, when colonies of individuals construct conspicuous webs over Devil's-bit Scabious leaves and adjacent vegetation. These webs are easily identifiable at some distance. Spring larval surveys can also be carried out, but the formation of large colonies is less common and hence the surveys less efficient.

Habitat suitability: Habitat suitability surveys should ideally be undertaken during September, when the Devil's-bit Scabious is most apparent. For each

site, the suitability of the habitats for marsh fritillaries should be assessed according to the following categories, which provide an approximate gradation of habitat suitability (from highly suitable to not suitable): 'Good condition'; 'Suitable, under-grazed'; 'Suitable, overgrazed'; 'Suitable, sparse'; 'Overspill'; 'Potential, rank'; 'Not suitable'. The assessment is based upon percentage of Purple Moor-grass and Devil's-bit Scabious, scrub cover, sward height and presence of tussocks. Each of these categories of habitat should mapped for each site, with a percentage cover estimated.

Sward height: This involves walking transects at 20m intervals through the habitat, and selecting random points no greater than 20m apart along each transect. At each point, the presence or absence of Devil's-bit Scabious within 1m is recorded and sward height assessed using the following scale: <10 cm = 1; 10-20 cm = 2; >20 cm= 3. In order to qualify as a suitable habitat for marsh fritillary butterflies, Devil's-bit Scabious needs to be recorded within 1m of a minimum of 50% of all random points, and sward height should be within the range of 10-20cm in at least 75% of the random points.

Mitigation, compensation and enhancement

Given the importance of this species, and the fact that the habitat required by marsh fritillaries cannot readily be recreated or translocated, the key mitigation measure should be to avoid the habitat if at all possible, through careful route selection. Fencing of areas of retained habitat is essential in order to protect them during road construction and maintenance activities.

Protecting the hydrological regime of the habitat supporting larval food plants is also particularly important. Local changes in hydrology can lead to the drying-out of habitats, resulting in the loss of entire marsh fritillary populations. Road construction can easily lead to changes in the hydrological regime, so it is particularly important to understand the drainage characteristics of marshy grassland areas to ensure that these are maintained into the future.

Due to the potential for habitat fragmentation associated with new roads, and the high risk of vehicle strike owing to the poor flight ability of the species, it is important to maintain connectivity between sites and thus ensure the ability of populations to persist. It is particularly important to conserve a cluster of suitable sites in proximity to one another in order to encourage genetic mixing and to facilitate linking of habitats for metapopulation stability. This is particularly important given the poor dispersal ability of the marsh fritillary.

In order to provide long-term opportunities for colonisation and hence population expansion, new species-rich marshy grassland (with a high proportion of Devil's-bit Scabious) should be created in the vicinity of known marsh fritillary populations.

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AQUATIC INVERTEBRATES GROUP-SPECIFIC GUIDANCE NOTE

Group-specific Guidance Note: Aquatic Invertebrates

GENERAL CHARACTERISTICS OF THE GROUP

The majority of freshwater aquatic invertebrates are insects (including beetles, bugs and the larvae of several other Orders, such as dragonflies, stoneflies and caddis flies), but the group also includes molluscs (e.g. water snails, freshwater mussels etc.), crustaceans (e.g. crayfish, shrimps and isopods), leeches and a number of other, more obscure groups.

Aquatic invertebrates are often used as biological indicators of water quality, on the basis of the relative vulnerability of different groups to organic and inorganic pollution. Given that road projects have the potential to affect water quality, surveys for aquatic invertebrates are often therefore appropriate both to assess the intrinsic nature conservation value of the watercourse or wetland feature and the presence of important invertebrate species; and to help monitor the environmental effects of such infrastructure schemes.

In general, surveys and impact assessments for aquatic invertebrates usually focus on macro-invertebrates; microscopic fauna tend not to be investigated for the purposes of ecological assessment, nor as biotic indices of water quality, owing to the greater level of complexity and difficulty involved with surveying and identifying these groups. Different survey techniques are appropriate for freshwater pearl mussel (*Margaritifera margaritifera*) and white-clawed crayfish (*Austropotamobius pallipes*) see relevant Key Cards. It should be noted that a licence is required from the NPWS to survey for these species.

POTENTIAL IMPACTS OF ROAD PROJECTS

There are many aspects of road construction and operation that can have adverse impacts on aquatic invertebrate species; these include the loss, fragmentation and degradation of river, pond or wetland habitat, as well as direct mortality of individuals. In particular, many road projects cross, or run adjacent to, watercourses and/or water bodies that may be important for aquatic invertebrates, and there is thus a risk that valuable assemblages may be affected by polluted run-off from roads (especially through increases in suspended solids and significant changes in hydro-chemistry).

Conversely, both new road projects and the management of existing roadside landscapes also present considerable opportunities to enhance and protect wetland habitats for aquatic invertebrates, in particular through the creation of drainage features that deal with existing sources of pollution and/or also benefit biodiversity by creating new habitat features (see below).

SURVEY TECHNIQUES

It is important to recognise that general surveys for aquatic invertebrates are only likely to be required should the desk study reveal that particularly important species or assemblages are likely to be present, and/or that watercourses or water bodies of particularly high quality could be affected. The desk study, inspection of the feature in question during the multi-disciplinary walkover survey, and consultation with the NPWS, Regional Fisheries Boards and other relevant consultees should therefore be sufficient to determine whether a survey is needed, and if so the

type of survey methodologies that may be required. Any requirement for individual species surveys (e.g. for freshwater pearl mussels or white-clawed crayfish) should also be triggered in this way. The surveys for these species differ from the general procedures set out below and specific methodologies are presented separately on the subsequent Key Cards.

Three principal methods are most often employed to sample for aquatic invertebrates: sweep/pond netting is used to collect species from the water column and from amongst submerged and emergent vegetation; 'kick-sampling' collects species that shelter in stony substrates (the method involves disturbing the substrate with a foot and collecting dislodged animals in a net); and hand searching is used to collect species not readily sampled by the other methods (e.g. those underneath or attached to rocks, logs or other vegetation). In deeper water, samples can be collected by trawls with a dredge or trawl net, followed by sweeping with a pond net.

In contrast to surveys carried out for terrestrial invertebrates, relatively standardised protocols (based on the methods described above) exist for the sampling of aquatic habitats. This is largely as a result of the widespread use of aquatic invertebrates for assessing, and monitoring changes in biological water quality. Ponds and ditches are normally surveyed by collecting a 3-minute 'habitat-proportional' sample, in which the amount of time spent kick-sampling, sweep-netting or hand-searching a habitat is in proportion to the relative frequency of that habitat in the survey area. For rivers and streams, the EPA Biotic Index Methodology ('Q Value'), based on a 2-minute kick sample (or active sampling) with a 2mm mesh net, primarily in 'riffle' sections is generally appropriate. This can be followed by a hand search to ensure that potentially important species that are not sampled effectively by kick samples are not missed. For watercourses of particular nature conservation importance, a more comprehensive 'conservation assessment' can be required, in which the hand search is extended to 30 minutes' duration. In deeper water, samples are collected by three to five trawls with a dredge or trawl net, followed by a one-minute sweep with a pond net.

In order to ensure that scarce or rare species of conservation importance are detected, it is normally appropriate that all samples of aquatic invertebrates from rivers, streams, ponds and ditches that may be affected by a road project should be identified to the species level. This is important for evaluating the nature conservation importance of the assemblage that may be affected. A variety of environmental measurements should also be recorded at the time of the survey (including the width and depth of the stream (or dimensions of the pond), the pH of the water, and the percentage cover of boulders, gravel, sand and silt) to provide contextual habitat information to help inform the assessment of the aquatic invertebrate assemblage. Fixed point photographs are also useful.

Collecting samples is a relatively quick process, although sampling at a number of stations is often necessary. At the very least, where a watercourse is to be affected, there should be one upstream (control) and one downstream sample. It may also be necessary to collect more than one sample per visit for a pond, especially if it is large and it is considered that one sample would not sufficiently represent all of the habitats present. Samples should be collected on at least two separate occasions, one in spring (March to May) and one in autumn (September to November). In some cases, especially in potentially valuable lakes and ponds, a third (summer) sample is also advisable.

These surveys will not only allow for an assessment of the nature conservation value of the aquatic fauna to inform the impact assessment, but will also establish a baseline for subsequent monitoring

of the effects of the construction and operational phases of the road project on biological water quality in the receiving watercourses.

It is imperative that **biosecurity measures** are taken when carrying out aquatic invertebrate sampling in order to avoid the incidental spread of vector borne diseases such as crayfish plague between watercourses. This includes cleaning, appropriate disinfection and thorough drying of all equipment between surveys undertaken on different watercourses.

MITIGATION, COMPENSATION, ENHANCEMENT

In order to protect valuable aquatic invertebrate assemblages, measures should be taken, wherever possible, to avoid affecting important aquatic habitats (e.g. through careful route selection). Where avoidance is not possible, it is recommended that impacts should be minimised through sensitive design, including small-scale variations in alignment, minimising the extent of land-take, and using clear-span bridges/ viaducts to take roads over watercourses or water bodies.

As well as avoiding direct impacts, indirect effects, such as adverse hydrological changes, pollution and disturbance, should also be minimised through sensitive design and good engineering practice, wherever possible. The careful design of the construction site and future road drainage is particularly important, and consideration should be given not only to the incorporation of standard attenuation and pollution control measures to protect aquatic invertebrates, but also vegetative drainage systems. These tend not only to protect downstream habitats from pollution and/or sedimentation, and provide attenuation, but will also provide potentially valuable wetland habitat within or adjacent to the roadside landscape.

Both new road projects and improvements and the management of existing road landscapes (in particular, the drainage elements) thus also present considerable opportunities to enhance and protect habitats for certain aquatic invertebrate species, in particular through improved pollution controls, habitat enhancement and appropriate management (especially through modifications to routine verge maintenance). In particular, the creation of drainage ditches/or attenuation ponds designed specifically to optimise their value for biodiversity, can have net beneficial effects on aquatic invertebrates.

KEY CARD: Freshwater Pearl Mussel (*Margaritifera margaritifera*)

Description

The freshwater pearl mussel is a bivalve mollusc. It is the largest freshwater mollusc in Ireland, and can grow up to 15cm in length. It is generally black in colour and oval in shape. It has a heavy shell which is often concave along the ventral margin and eroded at the apex. These mussels have a slow growth rate and will grow in aggregations in gravel beds between boulders.

Freshwater Pearl Mussel (*Margaritifera margaritifera*) Photo: Evelyn Moorkens

Life-Cycle and Behaviour

The mussel spends its larval, or glochidial, stage attached to the gills of salmonid fishes. The larvae attach themselves during mid- to late-summer and drop-off the following spring to settle in the riverbed gravel where they grow to adulthood i.e., five years old. This species does not reach reproductive maturity until it reaches between 7 and 15 years old, and may live for over 100 years.

Habitat Preferences

The freshwater pearl mussel occurs in watercourses with clean, cool, well-oxygenated water, having a lack of calcium and a low mineral content (which accounts for their very slow growth). Patches of clean sand or gravel between large boulders and cobbles provide suitable substrate for burrowing. Suitable micro-habitats include stretches of river with overhanging trees which provide shade, areas of river bed with gravel and/or boulders (away from solid rock) and at the exit point of lake outflows.

Survey Techniques

If the presence of watercourses suitable for use by freshwater pearl mussel are identified during the multi-disciplinary walkover and desk study, and should the proposals potentially have a significant impact on these features, then it would be appropriate to undertake more detailed surveys. Guidance on surveying for freshwater pearl mussels has been produced by NPWS which identifies four stages of surveys:

Stage 1 involves confirming presence or absence of the species from suitable habitat within shallow water using a glass-bottom bucket. The search should be concentrated in areas most likely to support freshwater pearl mussels. Care should be taken to minimise trampling and damage to freshwater pearl mussels using this method. If presence is confirmed, to minimise damage, a Stage 2 survey should be undertaken.

Stage 2 involves the use of snorkling techniques to estimate the number of adults within a river; this will allow a quantitative assessment to be made. NPWS guidance states that any freshwater pearl mussels recorded should not be removed from the channel.

The NPWS guidance should be referred to for more details. In almost all circumstances associated with a proposed road scheme, Stage 1 and 2 surveys will be sufficient in order to provide enough information to inform a comprehensive assessment. *Stage 3* refers to establishing whether or not there is successful recruitment to the population, whilst *Stage 4* surveys monitor the status of specific populations, and monitoring studies should be designed in consultation with NPWS and other relevant consultees.

It is imperative that **biosecurity measures** are taken when carrying out freshwater pearl mussel surveys in order to avoid the incidental spread of vector borne diseases such as crayfish plague between watercourses. This includes cleaning, appropriate disinfection and thorough drying of all equipment between surveys undertaken on different watercourses.

Optimum Survey Period

Viewing surveys using a bucket should be undertaken during periods of low flow between April and September during bright sunshine. Although surveys can be undertaken during spring and autumn, light levels are low during this period and this can make undertaking surveys problematic. Snorkling surveys will generally need to be undertaken during spring and autumn, when water levels are higher.

Mitigation, compensation and enhancement

Effective mitigation should be designed on a site- and project- specific basis, however a number of general principles apply. The most important mitigation measure is avoidance or minimising the loss of habitat suitable for freshwater pearl mussels. This can be achieved through sensitive route alignment to avoid water bodies, crossing watercourses with clearspan structures, and at a 90º angle rather than a more oblique one, and avoidance of culverting, in order to minimise impacts on watercourses. Freshwater pearl mussels are particularly susceptible to sedimentation and pollution and comprehensive measures should be taken to protect water quality. Similarly, measures should be taken to protect the existing hydrological regime.

If direct impacts on freshwater pearl mussels cannot be avoided, it will be necessary to undertake a site-specific review with NPWS, EPA and other relevant consultees to determine appropriate mitigation. The translocation of individual Pearl Mussels should be seen as a last resort, as the success of these activities cannot be guaranteed. Furthermore, given the slow growth rates of mussels, it can take a long time for a population to recover from interventions of this kind.

Where road projects result in permanent changes to sections of river incorporating important features, it may be appropriate to compensate for these effects by a suite of enhancement measures. These would need to be specifically tailored to meet individual circumstances, but would include creation of micro-habitats by planting of appropriate bank-side vegetation including mature trees to provide shade; stream profile design to create appropriate flow patterns; and the translocation of substrate to create suitable areas of gravel and boulders.

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KEY CARD: White-clawed crayfish (*Austropotamobius pallipes*)

White-clawed crayfish (*Austropotamobius pallipes*) Photo: Cresswell Associates

Description

The white-clawed crayfish is Ireland's only native crayfish.

It is a freshwater crustacean that can grow up to 120mm in length. It has five pairs of legs, the first of which are large claws with a pink underside. A distinguishing feature of the white-clawed crayfish is a spine, located in the groove between the head and the carapace. Males can be identified by a pair of appendages on the abdomen, whilst females have a broader abdomen adapted for carrying eggs.

The white-clawed crayfish has suffered substantial declines in populations over the past century, attributable to water pollution, habitat destruction, disease and competition. Crayfish 'plague' is a key threat to the white-clawed crayfish. Although non-native crayfish, which act as vectors of the disease are considered absent from Ireland, outbreaks have occurred which are thought to have drastically reduced populations of white-clawed crayfish in some catchments.

Life-Cycle and Behaviour

White-clawed Crayfish are most active during the summer. They feed on invertebrates, small fish, macrophytes and algae. Breeding usually takes place between September and November following a reduction in water temperature. Eggs are carried by the female over the winter and released between May and July.

Habitat Preferences

In Ireland, the white-clawed crayfish is found in lowland rivers, streams, lakes and field boundary ditches with suitable gravel substrates. The most suitable of each of these habitat features are those with good water quality, where water contains sufficient lime, and where suitable refuges exist. However, they may also be found in adjoining ditches and culverts, including those with poor water quality.

Survey Techniques

If the presence of watercourses and/or waterbodies suitable for use by white-clawed crayfish is identified during the multi-disciplinary walkover and desk study, and should the proposals unavoidably have a significant impact on these features, then it would be appropriate to undertake more detailed surveys. A combination of manual searching, trapping and nocturnal torchlight survey is the most effective approach to survey for white-clawed crayfish. The characteristics of individual watercourses will determine which of these methods is most appropriate in each instance. It would also be appropriate to confirm the choice of techniques with relevant consultees, including the NPWS, and relevant Regional Fisheries Board, to ensure that trapping in particular would be appropriate/permitted. Standardised methodologies have been developed which allow comparison between different sites. All survey methods must be undertaken working in an upstream direction.

Manual searches: For manual searching, five suitable patches of habitat should be selected within a 100-200m section of the watercourse/waterbody. The ten most suitable refuges within each patch should be searched for the presence of white-clawed crayfish. The average number of individuals per patch is then used to calculate relative abundance. This survey method is only suitable in clear water of a depth of no more than 60cm. If no crayfish are recorded, this methodology should be repeated within a different stretch of the watercourse or waterbody.

Trapping surveys: Trapping surveys can be carried out in turbid water and in water depths greater than the maximum 60cm required for manual searches. A minimum of ten to twenty baited fine mesh traps should be set in a 100-200m section of the watercourse in suitable locations at 2-4m intervals. Traps should be set overnight and checked the following morning. Trapping should be carried out on two separate occasions should no crayfish be caught on the first occasion.

Torchlight surveys: Nocturnal torchlight surveys are suitable for use in clear, shallow waters. Torchlight surveys of a 100m section of the watercourse should be undertaken when it is fully dark, and these involve searching for white-clawed crayfish in the watercourse, up to 2m from the bank. Crayfish numbers are recorded after every 3m of bank searched. Wherever surveying from within the channel is necessary, care should be taken to avoid inadvertently stepping on crayfish during these surveys.

As an additional survey method, sweep netting can be useful in confirming the presence of juvenile crayfish. Sweep netting should be undertaken in at least ten areas of submerged fine tree roots and vegetation within a 100-200m section of the watercourse.

It is imperative that **biosecurity measures** are taken when carrying out crayfish surveys to avoid the incidental spread of crayfish 'plague' between watercourses. This includes cleaning, appropriate disinfection and thorough drying of all equipment between surveys undertaken on different watercourses.

Optimum Survey Period

August to September is the optimum survey period for white-clawed crayfish. Although surveys are possible earlier and later in the year, absence of the species should not be inferred during this period. Manual searching should not be undertaken between end-May to July when females carrying young are most susceptible to disturbance.

Mitigation, compensation and enhancement

Whilst effective mitigation should always be designed on a site- and project-specific basis, a number of general principles apply. The principal mitigation measure should be avoiding or minimising loss of suitable crayfish habitat. This can be achieved through sensitive route alignment to avoid waterbodies, crossing watercourses at a 90º angle rather than a more oblique one and with clear-span structures wherever possible, and avoidance of culverting in order to minimise impacts on watercourses. Appropriate measures should be taken to protect water quality and the hydrological regime.

To avoid the impacts of fragmentation on white-clawed crayfish populations, new watercourses should be sensitively designed to incorporate features of value to crayfish. New channels should be slow-flowing with pools and riffles, suitable crayfish refuges (e.g. stones and cobbles of a variety of sizes) should be incorporated, and both banks and channel-bed should be sensitively reinstated. Features such as weirs, dams, shallow water, fast flows and concrete substrate should be avoided as they may act as a barrier to movement and isolate populations.

If direct impacts on crayfish populations are considered likely, it will generally be appropriate to undertake a crayfish 'rescue'. An appropriate receptor site should be identified prior to works taking place. For watercourses, this should be located upstream of the affected watercourse. Appropriate habitat enhancement measures should be incorporated at the receptor site to promote the survival of translocated individuals, including provision of suitable refuges.

A combination of 'wet' and 'dry' trapping methods should be used to capture the crayfish. Wet working methods include the removal of refuges from the channel and bank-sides, manual searching and intensive trapping. Removed refuges should be stockpiled for use in habitat reinstatement/enhancement. Dry working methods involve draining water from the channel and capturing individuals as they emerge from refuges. Three draw-down events are recommended to maximise the number of individuals rescued. Structures and burrows suitable for use by crayfish should be carefully dug-out/dismantled using hand tools or by a machine overseen by a suitably qualified ecologist, following the removal of refuges and as many crayfish as possible.

Key reference

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FISH
GROUP-SPECIFIC GUIDANCE NOTE

Group-specific Guidance Note: Fish

GENERAL CHARACTERISTICS OF THE GROUP

This is an extremely diverse group of animals and can be classified into several groups, including jawless fish (such as the lampreys), cartilaginous fish (rays and sharks) and the bony fish (the majority of other species).

Fish may be found in almost all aquatic habitats, including rivers, streams, lakes, and ponds in both upland and lowland areas, and in estuarine or coastal waters. Road projects may affect any of these natural habitats during construction (e.g. removal of habitats) and operation (e.g. through polluted run-off); but fish may also utilise man-made habitats, such as highway drainage ditches, balancing ponds and other related structures.

In Ireland, there are approximately 25 species of fish which inhabit freshwater habitats. This includes native species, such as the char (*Salvelinus alpinus*) (which is found only in western upland lakes), and introduced species, such as perch (*Perca fluviatilis*) or pike (*Esox lucius*). Other species have a life-cycle which encompasses both freshwater and marine habitats. Sea and river Lamprey (*Petromyzon marinus* and *Lampetra fluviatilis*) and atlantic salmon (*Salmo salar*) live predominantly in the sea but migrate to breed in fresh water (this is known as an 'anadromous' life-cycle), whereas freshwater eels (*Anguilla anguilla*) live predominantly in freshwater but migrate to breed in the sea ('catadromus' life-cycle).

Typically, fish breed by spawning, where the female lays eggs directly into the water to be fertilised by the male. When these eggs hatch, the fish go through a short-lived larval stage before maturing as adults. There are a variety of names for the various life stages of each fish species. The life-cycle for each of the key protected species is described on the relevant Key Cards.

Clean, unpolluted, waters provide the best habitats for fish. Of greatest importance for freshwater and anadromous fish are the sections of rivers or streams used for spawning. Whilst each species has its own habitat preferences (set out on the Key Cards for the selected species), most favour stable gravel substrates, which provide a safe area for the developing eggs.

POTENTIAL IMPACTS OF ROAD PROJECTS

There are many aspects of road construction and operation that can have both temporary and permanent adverse impacts on fish. These include increases in sedimentation or chemical pollutants, that, if sufficiently severe, may cause direct mortality of fish or, at lower concentrations, may promote eutrophication, affecting water quality and, consequently, a deterioration in the diversity and biomass of (other) aquatic species. Modifications to channel morphology, including the construction of bridge piers, bank stablisation works, or any alteration of flow regimes which may contribute to changes in downstream erosion and sediment deposition, can also affect fish. The introduction of barriers to fish migration, which may be chemical or physical, present potentially significant impacts to some species in particular. In addition, the loss of aquatic plants resulting from shading, due to the construction of structures and the accidental introduction of non-native (particularly of invasive) species, can also be an issue.

The cumulative nature of minor impacts may lead to the overall degradation of aquatic habitats generally, as well as having direct impacts upon the more critical sites such as spawning and nursery grounds. It is important to consider impacts which may also have 'knock-on' effects downstream.

Conversely, both new road projects, improvements, and the management of existing highways infrastructure present considerable opportunities to enhance and protect wetland habitats for fish and other aquatic species, e.g. through improvements in pollution controls.

SURVEY TECHNIQUES

The findings of the multi-disciplinary walkover survey and the desk study along with consultations with NPWS and relevant Regional Fisheries Board should inform the need for targeted fish surveys. The walkover survey should identify where route options cross rivers and streams and should describe the nature of the rivers at these crossing points, in particular with regard to the importance of such sections of river as suitable spawning or nursery habitats. Consideration should also be given to the nature of the river downstream of the proposed crossing location and the potential for direct impacts for at least 1km downstream should be assessed. Desk study information should provide details of the importance of rivers for fish populations, in particular for salmonid fish stocks. Information on the water quality of the river should also be examined, as there is generally a correlation between water quality and the abundance and diversity of fish species within a river system. It may be appropriate to site fish survey locations near to EPA water quality monitoring stations.

Prior to undertaking fish surveys, it is also important to consider the scale of impacts that the activities associated with road construction and operation will have on the river. It will only be appropriate to undertake detailed surveys where significant impacts are anticipated on potentially valuable assemblages of fish, or important populations of a particular species.

Many of the survey techniques for fish are not species-specific and therefore surveys will often provide information on the diversity of species within a river, as well as providing information on the abundance of any one species.

The most commonly employed techniques are the use of temporary or permanent fish traps with fish counters; these can provide data across an extended period of time and can help to identify particularly important seasonal variations in fish species and abundance. In addition, direct observation can be used, particularly during spawning, when the presence of aggregations of fish can be identified. Electro-fishing is also a commonly used technique, both from the bank or from a boat within the river channel. This can include spot-fishing within suitable areas of channel using portable electrical fishing units, and/or more detailed methods using fine-meshed enclosures. Use of electro-fishing should be carefully timed to avoid key spawning periods and periods in which larval and juvenile fish are present, as electro-fishing can be unsafe for fish in these life stages.

Water quality monitoring data, both through chemical studies and through the monitoring of macroinvertebrate fauna, should also be collected and used to inform any assessment, as this

provides reliable information on the diversity of aquatic fauna within a river. Such information will also provide valuable baseline information against which the performance of mitigation measures can be monitored post-construction.

Other survey techniques include visual surveys from the banks or from in-stream snorkelling surveys, passive fish nets, the sieving of silt and sand from a riverbed, and kick sampling, although the last two techniques should be used with caution as they will almost always lead to the death of larval and juvenile fish species, should they be present.

In all cases, fish survey protocols should be reviewed with the NPWS, the relevant Regional Fisheries Board, and other relevant consultees. The aim should be to avoid, or at least minimise, the use of labour-intensive, invasive surveys. Wherever possible, impact assessments should make maximum use of existing information and consultations, adopting a precautionary approach.

Fish surveys, in particular, trapping and electro-fishing surveys, must be undertaken by experienced ecologists as there is a risk to the welfare of animals associated with the use of both techniques. Electro-fishing also requires a licence from the Minister for Communications, Energy and Natural Resources and in consultation with the relevant Regional Fisheries Board. The Minister for the Environment must also be informed prior to its use.

Key Cards are presented on Atlantic salmon, the three species of Lamprey found in Ireland and the three species of Shad. The survey techniques described in each of these Key Cards will involve the use of one or more of the techniques described above, although the timings of surveys will vary for different species.

MITIGATION, COMPENSATION AND ENHANCEMENT

Wherever significant impacts on water courses containing valuable or diverse assemblages of fish are anticipated, appropriate mitigation measures should be developed in consultation with the appropriate Regional Fisheries Board, NPWS and other relevant consultees.

It is often possible to avoid significant impacts on rivers and aquatic habitats that have been identified as being of value to fish species through sensitive design. This can include features such as clear-span bridges, which avoid the need to affect the river channel. Throughout construction, it will be particularly important to minimise the impacts of construction activities on watercourses. In particular, sediment released during construction can impact spawning gravels, choke fish and smother larvae or young fish. It can also have a significant negative impact on the aquatic flora and macro-invertebrate populations upon which the fish depend and therefore effective pollution and sedimentation controls will need to be designed and implemented. Where stream diversions or works to channels are unavoidable, appropriate mitigation, including downstream sediment controls and, potentially, fish 'rescues' should also be implemented. (see NRA watercourse crossing guidelines as well as relevant fisheries publications for details regarding salmonids close season etc.)

Appropriate pollution control and attenuation measures associated with the new roads and improvements themselves, should also be carefully designed and implemented to protect water quality in the receiving watercourses.

If in-channel works are required that would result in the loss of important habitats for fish, such as spawning grounds or nursery areas, efforts should be made to recreate such habitats following completion of construction operations. This can include the creation of gravel beds and/or recreating a range of 'natural' channel features, such as 'riffles', 'pools' and 'glides'.

For road improvement projects, there may also be opportunities to improve the quality of the existing watercourse system by installing improved attenuation and pollution control measures, and/or by removing or re-designing any in-channel structures to remove obstructions to fish migration.

Key reference

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KEY CARD:

Lamprey Species

Description

Lampreys are primitive, jawless fishes resembling eels. Three species of lamprey occur in Irish waters: the brook lamprey (*Lampetra planeri*), river lamprey (*L. fluviatilis*) and sea lamprey (*Petromyzon marinus*). Both sea and river lamprey are anadromous species that spawn in freshwater but complete their life-cycle in the sea. The sea lamprey is the largest of the three lamprey species, followed by the river lamprey and the brook lamprey, respectively.

Brook lamprey (*Lampetra planeri*)

River lamprey (*Lampetra fluviatilis*)
Photos: Frei/Arco and Willem Kolvoort, Naturepl.com

Life-Cycle and Behaviour

All three species of lamprey have a life-cycle which includes both a sedentary larval (ammocoete) stage and an adult dispersal phase during which spawning takes place. River lamprey migrate upstream from the sea to spawning grounds in autumn/spring, with spawning taking place in the spring. Sea lamprey migrate upstream in early spring and spawn in late spring/early summer. The ammocoetes of the river and sea lamprey spend several years within soft river sediments before migrating to sea as adults. The brook lamprey spend their entire lifecycle within the river, spawning in mid-spring, March to April, as well as having an ammocoete phase in silts.

Habitat Preferences

Sea lamprey occur in estuaries and easily accessible rivers and have a preference for warm waters in which to spawn. In comparison to river lamprey, sea lamprey seem to be relatively poor at ascending obstacles to migration, and are frequently restricted to estuaries and the lower reaches of accessible rivers. Records of sea lamprey suggest that their distribution in Ireland is relatively widespread, with the exceptions of the west Cork and Kerry coasts from the R. Lee to Castlemaine, and the Galway and west Mayo coastline where there are no records to date. The river lamprey is found in coastal waters, estuaries and accessible rivers. In Ireland, river lamprey have been found in east and south-east coastal waters, Munster Blackwater, Killarney National Park, Lower Shannon and the Lough Gill catchment in Sligo, and also in the Slaney Estuary, which is thought to be the most important location for river lamprey in Ireland. The brook lamprey is a non-migratory freshwater species, occurring in streams and occasionally in lakes in north-west Europe. It spawns mostly in parts of the river where the current is not too strong. In Ireland, brook lamprey is widespread throughout the country, often occurring in the upper reaches

of watercourses well above the occurrence of river and sea lamprey. They have been observed in a tributary of Lough Ennell, the Slaney catchment and the Erne catchment.

All three species spawn in both rivers and streams in clean gravels, similar to those preferred by salmonids, and marginal silt or sand is required for the burrowing juvenile ammocoetes. The ammocoetes are usually found within the same catchments as adults, using similar micro-habitats.

Survey Techniques

The potential for rivers to support lamprey species should initially be assessed through an appraisal of the habitat suitability within the river, stream or ditch channel during the multi-disciplinary walkover survey, informed by the results of the desk study and consultations. This should include consideration of water quality, river or stream morphology and speed of flow. Where conditions are considered suitable to support lamprey, it will be necessary to review the need to undertake more detailed surveys, following the principles and methodologies described under '*Survey techniques*' in the GSGN for *Fish* Surveys should only be considered in those situations where significant impacts on lamprey are anticipated. In addition, the choice of survey technique should be informed by the characteristics of any potential impacts. For example, where the principal likely effect would be the creation of barriers to migration, it may be appropriate to confirm the use of the river by adults upstream of the potential barrier, by employing fish traps or counters, or direct observations of spawning adults. Where the works in question could affect potentially important nursery areas, ammocoete surveys would be more appropriate.

Surveys for adult and juvenile (ammocoete) lamprey differ. Recommended survey techniques for adults include temporary or permanent salmonid fish traps and counters. The most reliable and replicable method for assessing ammocoete populations is through electro-fishing, fish traps and counters, and direct observations of spawning adults. Typically, the conservation status of lamprey is assessed using the results of electro-fishing surveys for ammocoetes, rather than using fish counter data from fish traps. In the absence of a standardised methodology for assessing the conservation status of lampreys in Irish rivers, it would be appropriate to consider using the methodology developed for British rivers by Harvey and Cowx (2003). However, in each case, the need for invasive sampling should be reviewed in consultation with the NPWS, the appropriate Regional Fisheries Board, and other relevant consultees; wherever possible, impact assessments should be based on existing information, adopting a precautionary approach.

Optimum Survey Period

Surveys for lamprey ammocoetes should be carried out between August and October. Surveys for adult lamprey are most efficiently undertaken either by capturing adults as they return to the upstream spawning sites, or by direct observation at the spawning sites.

Mitigation, compensation and enhancement

The attenuation and pollution control measures discussed under the GSGNs for *Fish* and *Aquatic invertebrates* are all equally relevant for lamprey.

Should works be required within the river channel, suitable fish passages should be provided to ensure that neither upstream nor downstream migration is interrupted. Where in-stream works take place, it may also be necessary to de-water appropriate sections of the river using coffer dams and to translocate any individuals to areas of the river outside the zone of influence of the scheme. Wherever possible, in-channel works should avoid periods of lamprey migration between September and December.

Scheme design should take account of the quality of habitat associated with affected watercourses, and seek to avoid locating structures such as bridges in valuable sections of river, especially near spawning grounds. Where structures are required to cross important lamprey watercourses, structures should be designed to minimise alteration to river channel profile, width and depth, substrate and water flow. Where road projects result in permanent changes to sections of river incorporating important features, it may be appropriate to compensate for these effects by a suite of enhancement measures. These would need to be specifically tailored to meet individual circumstances, but may include the creation of pools and hollows, stream profile design, substrate enhancement measures, and planting of appropriate aquatic and bank-side vegetation.

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KEY CARD:
Atlantic Salmon
(*Salmo salar*)

DESCRIPTION

Atlantic Salmon
(*Salmo salar*)
Photo: Laurie Campbell

The Atlantic salmon is an anadromous species: that is, the majority of its growth and feeding is carried out at sea, but adult salmon return to spawn within freshwater streams and rivers, where the eggs hatch and juveniles mature through the '*alevin*', '*fry*', '*parr*' and '*smolt*' stages. After one to four years, depending on the latitude of the spawning river and the temperature of the water, the smolt migrate towards the sea. The colouration of Atlantic salmon varies throughout maturation, but all adults show black spots above the lateral line and all but the adipose fin are bordered with black.

Life-Cycle and Behaviour

As an anadromous species, Atlantic salmon spend much of their life within the marine environment, utilising rivers for their reproductive and nursery phases. Adult salmon typically return from the Atlantic to spawn in rivers between November and December, although spawning has been recorded between October and February. About 90-95% of spawning salmon die following their first spawning, although individuals have been reported that have survived up to four spawning events. Eggs are laid in '*redds*' excavated by female fish in the gravel bottom of rivers and are then immediately fertilised by male salmon. The eggs incubate within the river gravels in which they are laid. During this period, the stability of riverine gravels is critical, since high flows or disturbance to the gravels can destroy the '*redd*' and kill the developing eggs.

The hatching of the '*alevins'* takes place in early spring. The '*alevin*' emerge as '*fry'* from the river gravel sediments in April or May when they are approximately one inch long and develop into '*parr'*. They feed primarily on aquatic invertebrates, in particular insect larvae such as mayfly, stonefly and caddis. A range of habitat types is important for the successful development of salmon parr, since salmon show a preference for different depths of river and speeds of flow during different seasons. The length of time that the salmon parr remain within the river is dependent on the temperature of the river and can vary between one and four years. Young fish, or '*smolts'*, leave the river system for the sea, usually between April and June. Salmon may spend between one and four winters in the sea prior to returning to freshwater to spawn. Salmon returning to the river to spawn after one year are known as '*grilse*' while salmon that spend longer than this at sea are known as MSW (multi-sea-winter) salmon.

Habitat Preferences

The characteristics of the stream or river are important in determining its suitability for salmon. The characteristics of principal importance are water depth and velocity, stream-bed substrate and appropriate bank-side cover.

Salmon are known to use a variety of different habitats during their different life stages and during different seasons. Suitable habitats for juveniles comprise shallow, fast-flowing water with a reasonably coarse substrate. Gravels tend only to be used for spawning if they are in close proximity to suitable habitat for juveniles. A mixture of gravels for spawning and deeper pools downstream of the spawning areas is considered important to allow adults to congregate prior to spawning.

Salmon are recorded as needing very good water quality, typical of that found in spring-fed chalk streams and upland stream systems.

Survey Techniques

The potential for rivers to support Atlantic salmon should initially be assessed through an appraisal of the habitat suitability within the river channel during the multi-disciplinary walkover survey, supported by the results of the desk study and consultation (particularly with the EPA and appropriate Regional Fisheries Board). This should include consideration of water quality, river or stream morphology, substrate type and speed of flow.

Where conditions are considered suitable to support the species, it will be necessary to consider the need to undertake specific surveys to investigate the use of the watercourse by salmon. This will depend upon the type and extent of potential impacts and whether sufficient information already exists. Typically, salmon population numbers are monitored using temporary or permanent fish traps and fish counters. Electro-fishing can be used to monitor '*parr*' and '*smolt*' numbers within river systems. However, this technique should not be used while spawning adults are present within the river as the use of fish counters is considered to be more efficient. In all cases, the need for specific surveys should be reviewed with the relevant Regional Fisheries Board, the NPWS, EPA and other relevant consultees. As with other important fish species, impact assessments should, wherever possible be based on existing information, adopting a precautionary approach.

Optimum Survey Period

Surveys using fish traps are most effective between October and February as the adult salmon move up the river to spawn. However, surveys for salmon parr using fish traps can be undertaken at any time of year. Electro-fishing surveys should be avoided while spawning adults are present within the relevant part of the river.

Mitigation, compensation and enhancement

The attenuation and pollution control measures discussed under the GSGNs for *Fish* and *Aquatic invertebrates* are all equally relevant for salmon.

Should in-channel works be required, the effects on upstream migration will need to be considered and, where necessary, fish passages created to ensure salmonid migration is not disrupted by the development. In-stream works should not be carried out in watercourses frequented by salmon or trout during the Annual Close Season. The duration of the season varies regionally within the period from the beginning of October to the end of February. The timing of works should always be considered on a site specific basis and in agreement with the RFB because some rivers have late spawning salmonids. For this reason, it is important to develop mitigation measures in close collaboration with the relevant Regional Fisheries Board and the NPWS.

Scheme design should take account of the particular habitat features associated with the affected sections of the watercourse in question, and seek to avoid locating structures such as bridges in sections of the river incorporating features favoured by spawning, migrating or maturing salmon. Where road projects would unavoidably result in permanent changes to sections of river incorporating key features, it may be appropriate to compensate for these effects by a suite of enhancement measures. These would need to be tailored to meet individual circumstances but may include the creation of 'pools' and 'glides', substrate enhancement measures, and planting management of appropriate bank-side vegetation.

Key reference

- Cowx, I.G. & Fraser, D., 2003. Monitoring the Atlantic Salmon. *Conserving Natura 2000 Rivers Monitoring Series No. 7.* : English Nature.
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- NRA, 2006. *Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes*. Dublin: National Roads Authority.
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KEY CARD:

Shad Species

Description

Shad are pelagic fish and are part of the herring family. Two species of shad occur in Irish waters; the allis shad (*Alosa alosa*) and twaite shad (*Alosa fallax*). Both allis and twaite shad are anadromous species (*i.e.* spawning in freshwater but completing their life-cycles in the sea).

Twaite shad (*Alosa fallax*)

Allis shad (*Alosa alosa*)
Photos: Michel Roggo, Naturepl.com

Life-Cycle and Behaviour

Both shad species spawn in large rivers between April and June. Almost all allis shad die following their first spawning, although low levels of repeat spawning has been reported for some individuals. Unlike allis shad, the majority of twaite shad spawn several times in their lives. Females of both species of shad lay eggs above areas of clean gravel in river pools, which are then immediately fertilised by the male shad. Where allis and twaite shad share spawning grounds, hybridisation can occur, resulting in fertile offspring.

The fry of allis shad are about 10mm long on hatching, and hatch after 4-8 days. After hatching the young remain in the slow-flowing reaches of the lower parts of rivers and/or estuaries for 1-2 years before moving into the coastal waters. Maturity is reached at 3-4 years and most spawning adults are between 3-6 years old.

The fry of twaite shad take about 4-6 days to hatch, and after hatching, the young move quickly downstream to the upper estuary where they begin to mature. Maturity in males is reached at about 3 years and in females at about 5 years.

There are no known spawning populations of allis shad in Ireland, but spawning populations of twaite shad have been recorded in the rivers Suir, Nore and Barrow and the Cork Blackwater. There is also at least one non-migratory population of twaite shad in Lough Leane, which is considered a separate sub-species (*Alosa fallax killarnensis*) and known as the Killarney shad.

Habitat Preferences

Shad require large, unmodified, erosive river channels, normally at least 10m wide, with suitable resting pools and clean gravel beds at spawning sites. As they move slowly to the sea, young shad usually occupy open habitat at the edges of pools above the estuary where the current is less strong, and these lowland stretches are particularly important for the juvenile fish.

Survey Techniques

The potential for rivers to support shad species should initially be assessed through an appraisal of the habitat suitability within the river channel and the overall river characteristics during the multi-disciplinary walkover survey, supported by a review of the known distribution of the species and consultation with the NPWS, relevant Regional Fisheries Board and other relevant consultees. The habitat assessment should, in particular, include assessments of water quality, river morphology and speed of flow.

Given the information already available for these species, it will rarely be appropriate to undertake specific surveys for shad. However, in those situations where a road project would unavoidably have potential impacts on migrating fish, it may be necessary to investigate, e.g. the numbers involved and the precise timing of their migration in that area of the river. Fish counters of some kind may be the most appropriate techniques to use in this situation. In every case, specific surveys for shad should only be undertaken following consultation with the NPWS, EPA, relevant Regional Fisheries Board, and other relevant consultees.

Optimum Survey Period

Surveys for shad are most efficiently undertaken as the adults return to upstream spawning sites, between April and June.

Mitigation, compensation and enhancement

The attenuation and pollution control measures discussed under the GSGNs for *Fish* and *Aquatic invertebrates* are all equally relevant for shad.

Should in-channel works be required, the effects on both upstream and downstream migration will need to be considered and, where necessary, fish passages created to ensure shad migration is not disturbed by the development. Where in-stream works take place, it may also be necessary to de-water appropriate sections of the river using coffer dams, and to translocate any shad within these sections to areas of the river outside the zone of influence of the scheme. Wherever possible, in-channel works and other activities associated with, e.g. bridge construction that could create noise and vibration, should avoid periods of peak migration between April and June.

Scheme design should take account of the quality, and likely use by, shad of habitat associated with affected watercourses, and seek to avoid locating structures such as bridges in valuable sections of river, particularly in spawning grounds. Where structures are required to cross important watercourses for shad, design features should be incorporated to minimise alteration to river channel profile, width and depth, substrate and water flow. Where road projects result in permanent changes to sections of river incorporating important features, it may be appropriate to off-set these effects by a suite of enhancement measures. These would need to be specifically tailored to meet individual circumstances, and should generally seek to replicate the conditions that have been lost and/or affected.

Key reference

- Aprahamian, Lester and Aprahamian, 1998. Shad conservation in England and Wales. *Environment Agency Technical Report W110, 1-124*. Swindon: Environment Agency.
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- Henderson, 2003. Background information on species of Shad and Lamprey. *CCW Marine Monitoring Report No. 7*. Bangor: The Countryside Council for Wales.
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AMPHIBIANS
GROUP-SPECIFIC GUIDANCE NOTE

Group-specific Guidance Note: Amphibians

GENERAL CHARACTERISTICS OF THE GROUP

Three species of amphibians are found in Ireland: the smooth newt (*Triturus* (*Lissotriton) vulgaris*), the common frog *(Rana temporaria)* and the natterjack toad (*Bufo* (*Epidalea) calamita*). All three species hibernate during the winter and are restricted by their biology to return to ponds and other waterbodies to breed in spring/early summer. This key aspect of their behaviour underpins the survey techniques set out below.

POTENTIAL IMPACTS OF ROAD PROJECTS

New roads and improvements can result in the loss, degradation and fragmentation of habitats used by amphibians both directly and indirectly, e.g. by disrupting local hydrological conditions or polluting the waterbodies they use as breeding sites.

The process of site clearance and earthworks can result in the incidental mortality of individual amphibians and they can be killed attempting to cross roads, particularly during their breeding migrations in spring. Roadside drainage and pollution control structures also have the potential to trap and kill amphibians.

SURVEY TECHNIQUES

These rely on the field identification of amphibian populations at their breeding sites. Reliably detecting amphibian populations in terrestrial habitats away from their breeding sites or at other times of year requires a substantial amount of survey effort (and is simply not possible during the hibernation period) and therefore should be avoided wherever possible. Specific survey techniques for frogs and newts are presented on the following Key Cards. As identified above, the natterjack toad has a very limited range in Ireland, and is therefore unlikely to be affected by national road schemes. A Key Card for this species is not, therefore, included. Surveys for this species rely upon the identification of spawn 'strings' in the clear, shallow pools typical of these habitats and the vocalisations of breeding males, during late-spring and early-summer. In the unlikely event that a road project would unavoidably affect habitats likely to be used by natterjack toads, a site-specific survey and mitigation programme should be agreed with the NPWS.

It is imperative that **biosecurity measures** are taken when carrying out amphibian surveys in order to avoid the incidental spread of vector-borne diseases (such as crayfish plague) between waterbodies. This includes cleaning, appropriate disinfection and thorough drying of all equipment between surveys undertaken on different waterbodies and watercourses.

MITIGATION, COMPENSATION AND ENHANCEMENT

Where valuable features for amphibians, particularly their breeding waterbodies, have been identified, these should be avoided wherever possible, by alteration in alignment and/or land-take.

Measures should also be taken to avoid drying-out amphibian breeding sites through local disruptions to hydrology. Pollution of amphibian breeding sites should also be prevented, by the sensitive design of construction site drainage and the implementation of pollution control measures. Occasionally, road projects will present opportunities to improve habitat features for amphibians by, for example, increasing pond catchments or solving past pollution problems.

Where ponds would unavoidably be lost, it will be necessary to consider the position of replacement breeding sites, usually in accordance with the requirements of the derogation licences covering the works in question.

Similarly, in those situations where valuable terrestrial features for amphibians would unavoidably be affected, these should also be replaced through appropriate habitat enhancement, by creating, for example, wetland features and artificial hibernacula.

Where waterbodies that support particularly large amphibian populations cannot be avoided, it would also be appropriate to capture and relocate as large a proportion of the populations as possible prior to the works. Measures should also be considered to prevent harm to the populations during the construction period, e.g. through the use of exclusion fencing in the most critical locations.

Where a new road would sever what appear likely to be migration routes between different breeding sites within which substantial populations of amphibians have been recorded, or between these breeding sites and valuable terrestrial habitat features, consideration should be given to installing amphibian-proof fencing to guide them to purpose-built tunnels. However, the effectiveness of these measures remains unclear for smooth newts and common frogs.

KEY CARD:
Smooth newt
(*Triturus (Lissotriton) vulgaris*)

Smooth newt
(*Triturus vulgaris*)
Photo: David Kjaer, Naturepl.com

Description

As the only Irish amphibian whose adults possess tails, smooth newts are readily identifiable. Male and female smooth newts are also clearly distinct. Both sexes grow to approximately 10cm. Males are a brown/green colour on the upper body, with pale flanks and an orange belly. Females can vary in colour from pale to dark olive/brown with a paler belly and less pronounced spots. In the breeding season, the males develop a toothed crest from head to tail and bright blue and orange colour along the lower edge of the tail. When newts leave the water the skin becomes dull and 'velvety' and males begin to look more similar to females. Immature newts also resemble small females. Smooth newt larvae are predatory and resemble miniature pale brown adults, but with external gills and a more prominent tail.

Life-Cycle and Behaviour

Although a small proportion of newts overwinter in ponds, the majority hibernate on land and return to their breeding ponds in late-January/early-February. They mate and lay eggs (wrapping each of them in the leaves of aquatic plants) during April and May and the adults leave the ponds in June to spend the rest of the year in terrestrial habitats. Their larvae develop in the ponds until approximately September, when they begin to emerge.

Adult smooth newts spend the majority of their lives on land, during which time they are relatively inactive. They spend much of this time in refuges, emerging to feed at night, under relatively warm, damp conditions. They generally prey on small, soft-bodied invertebrates.

Habitat Preferences

Smooth newts tend to reach highest densities in fish-free ponds and ditches with a diversity of submerged and emergent vegetation. Deep, flowing or heavily shaded waterbodies are less favoured, but smooth newts can exploit a range of wetland features. They can also be found within a range of terrestrial habitat types in the vicinity of ponds, showing preferences for damp, un-grazed grassland, woodland and scrub.

Survey Techniques

Surveys for smooth newts will be required when waterbodies potentially suitable for use by breeding newts have been identified within approximately 250m of the proposed working area. If remote hydrological or pollution effects are likely on waterbodies at a greater distance, the survey 'corridor' should be extended, as appropriate.

In order to confirm the presence or absence of newts reliably, it is necessary to employ a combination of survey techniques and to re-visit the waterbodies in question at intervals over the period during which the number of breeding adults reaches a peak (late-March to late-May).

Waterbodies should be visited on up to four occasions during this time, ideally at roughly two-week intervals spread throughout the period, but with at least two visits in the early-April to early-May 'window'. On each occasion, a combination of techniques should be used, as determined by the conditions of the waterbody: torchlight inspections, egg searches, funnel trapping and dip-netting.

Torchlight inspections represent the most reliable and efficient technique in situations where visibility is good, and this combined with egg searching should represent the preferred option. These techniques should be supplemented by trapping and netting as appropriate, especially in situations where torching ability is compromised through water turbidity, access constraints and areas of bank-side vegetation. In order reliably to infer the absence of newts from an otherwise suitable waterbody, at least three techniques applied over the four visits is necessary. Cleary, if the presence of newts is established earlier, the survey can be suspended.

It is imperative that **biosecurity measures** are taken when carrying out amphibian surveys in order to avoid the incidental spread of vector borne diseases (such as crayfish plague) between waterbodies. This includes cleaning, appropriate disinfection and thorough drying of all equipment between surveys undertaken on different waterbodies and watercourses.

Optimum Survey Period

Surveys for smooth newts are seasonally constrained within specific periods. To survey for breeding adults within waterbodies, up to four visits should be undertaken, spread at intervals between late-March and late-May.

Mitigation, compensation and enhancement

In those situations where capturing and relocating important newt populations is considered appropriate, breeding ponds should be encircled by drift fencing and pitfall traps prior to the spring migration period, and newts captured on their way to breed. Netting and draining-down of ponds should also take place to remove as many of the remainder as possible.

Where large populations of newts are found close to the proposed works, amphibian-proof fencing can be helpful in protecting the resident animals. Permanent fencing can also be used to guide newts to purpose-built tunnels and other safe crossing structures, although their effectiveness for newts remains largely unknown.

Key reference

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- Marnell, F., 1997. *Amphibians*. In Fact Files on Nature. Dublin: Irish Wildlife Trust.

KEY CARD:
Common frog
(*Rana temporaria*)

Description

Common frog
(*Rana temporaria*)
Photo: Cresswell Associates

This is probably the most familiar amphibian in Ireland. Adult common frogs vary significantly in colour from brown, through olive, to yellow. They have a pale belly and often prominent black markings on the head, back and sides, and dark bars on the hind legs. Adults reach approximately 8cm long. Females each lay between 1000 and 2000 eggs which swell to form characteristic spawn 'clumps' or aggregated 'mats' of jelly-like eggs. Common frog tadpoles are greenish brown in colour and tend to gather around pond margins during sunny weather.

Life-Cycle and Behaviour

Common frogs hibernate for a short period from approximately mid-November to mid-January. Some hibernate in pond sediments, others in terrestrial hibernacula. Males assemble at their breeding ponds in late-winter/early-spring to await the females. Having bred, both sexes disperse from the spawning area but may stay around the pond or move into surrounding suitable habitat. Common frogs tend to feed on land at night, and take a range of invertebrate prey. Although they tend to frequent pond margins, they can also travel substantial distances over land between ponds. Tadpoles feed on a variety of micro-organisms, detritus and algae. They complete their metamorphosis and emerge from their natal ponds 10-15 weeks after hatching.

Habitat Preferences

Common frogs can exploit a wide range of habitats and can breed in anything from small puddles and ditches to the edges of large lakes and even slow-flowing parts of rivers. Although the tadpoles are vulnerable to fish predation, the adults do not appear to avoid ponds containing fish, but tend to spawn in the more inaccessible areas.

Survey Techniques

Common frog surveys should focus on recording vocalising males during the late-January/ early-February period, along with identifying spawn clumps and mats during February. Griffiths, Raper and Brady (1996) present a method for estimating the number of breeding animals and hence the

size of the local population by counting spawn clumps. Where difficulty in differentiating spawn clumps that have coalesced into a larger spawn mat is encountered, this method also provides a technique for establishing the number of clumps by measuring spawn mat area.

It is imperative that **biosecurity measures** are taken when carrying out amphibian surveys in order to avoid the incidental spread of vector borne diseases (such as crayfish plague) between waterbodies. This includes cleaning, appropriate disinfection and thorough drying of all equipment between surveys undertaken on different waterbodies and watercourses.

Optimum Survey Period

Vocalising males should be surveyed between late-January and early-February. Spawn clumps and mats should be surveyed and identified during February.

Mitigation, compensation and enhancement

Whilst adult common frogs can be captured using pitfall traps and drift fences, in those few situations where capturing and relocating important frog populations is considered appropriate, this should also involve moving spawn and netting adults in the ponds during the early part of the breeding season. Amphibian-proof fencing close to ponds can be effective in preventing frogs gaining access to the most hazardous parts of construction sites, and permanent fencing can be used to guide frogs to purpose-built tunnels and other safe crossing structures.

Key reference

- Beebee, T. and Griffiths, R., 2000. *New Naturalist No.87: Amphibians and Reptiles*. London: Harper Collins Publishers.
- Griifiths, R.A., Raper, S.J., & Brady, S.D., 1996. *Evaluation of a standard method for surveying common frogs* (*Rana temporaria*) and newts (*Triturus cristatus*, *T. helveticus* and *T. vulgaris*). In JNCC Report, No. 259. Peterborough: Joint Nature Conservation Committee.
- Marnel, F., 1997. *Amphibians*. In Fact Files on Nature. Dublin: Irish Wildlife Trust.
- NPWS, 2007. *Background to conservation assessment for common frog* (*Rana temporaria*). In NPWS Conservation Status Assessment Report. Dublin: NPWS.

REPTILES
GROUP-SPECIFIC GUIDANCE NOTE

Group-specific Guidance Note: Reptiles

GENERAL CHARACTERISTICS

There are two terrestrial reptiles in Ireland: the viviparous lizard (*Lacerta (Zootoca) vivipara*) and the slow-worm (*Anguis fragilis*).

Both species hibernate during the winter and give birth to live young, during the summer. They both need to bask in order to raise their body temperatures, and this fundamentally affects their habitat requirements and underpins the techniques used to survey them.

POTENTIAL IMPACTS OF ROAD PROJECTS

New roads and improvements can necessitate the loss, degradation and fragmentation of habitats used by foraging, basking and/or hibernating reptiles. The process of site clearance and earthworks can also result in the incidental mortality of individual reptiles. Reptiles can also, in some circumstances, be killed attempting to cross new roads, once constructed.

Conversely, new road projects have the potential to create habitat features that benefit reptiles. Roadside landscapes often contain a range of features, including south-facing banks, variable micro-topography and substrate exposures and a mosaic of grassland, heath and scrub habitats that can provide additional resources for local reptile populations. More extensive areas of suitable verge habitats can support high densities of reptiles in their own right. New road projects therefore have the potential to link fragmented reptile populations and extend the range of others through the creation of valuable verge habitats. However, this means also that management and maintenance operations that involve roadside landscapes can affect these populations.

SURVEY TECHNIQUES

Reptile surveys should employ a combination of two techniques: direct observation and the use of artificial refuges.

Direct observation involves observing and identifying basking animals. Carrying this out effectively relies upon undertaking the search under suitable weather conditions (see below) and the ability to identify and interpret suitable reptile habitats, since predicting where basking animals are likely to be found is a crucial part of carrying out a successful survey.

Reptiles tend to seek out structures that both act as places of shelter and aids in absorbing heat. By distributing artificial refuges, it is possible to make use of this behaviour to find basking reptiles. Animals can be found sheltering/basking beneath them or basking on top. Roofing felt, corrugated metal or heavy-gauge rubber are the best materials, cut to a minimum of 0.5m^2. Heavyweight flame-activated bituminized roofing felt should be used beside roads, since other materials can represent a hazard to vehicles. Artificial refuges should be positioned where they are most likely to be used by basking animals, distributed amongst a range of aspect and shade conditions, with the majority in south-facing locations in partial shade. A density of no fewer than 10 artificial refuges per hectare should be used, with greater concentrations around key habitat features.

The most effective approach is to combine both techniques by searching suitable basking spots whilst moving between artificial refuges.

In general, the best months during which reliably to find reptiles are April to mid-/late-May, and mid-/late-August to mid-September, depending upon the weather conditions at the beginning and end of each period.

The most appropriate times within which to survey will depend upon temperature, sunshine, rainfall and other weather parameters. Generally, in these months, the best times of day are between 0830 and 1100, and between 1600 and 1830. Very early or late in the year, the middle part of the day will be more productive, whereas during the hotter parts of the year, reptiles will be found basking earlier and earlier. Between June and mid-August there can be a very narrow 'window', early in the morning, and again in the later, cooler part of the day, within which either kind of survey is effective.

When the air temperature exceeds 18^{O}C many reptiles may not be found basking at all and surveys, particularly using refuges, will be unreliable. Surveys will be most effective when the air temperature is between 9 and 18^{O}C.

Generally, hazy or intermittent sunshine provide the most productive conditions, but bright sunshine early in the day in cool weather can also be suitable. Weather patterns can also be important: numbers of lizards recorded by direct observation tend to increase during warm weather following a period of colder conditions, or following rain showers. Thus the preceding weather conditions are important; periods of sunshine after rain tend to be important triggers for increased reptile activity.

Specific survey techniques for viviparous lizard are presented on the following Key Card. The general techniques and considerations described for this species are also relevant to slow-worms, although a greater emphasis should be placed on the use of artificial refuges, since slow-worms tend to be difficult to detect by observation of basking animals.

MITIGATION, COMPENSATION AND ENHANCEMENT

Where valuable features for reptiles have been identified, these should be avoided wherever possible, by small-scale variations in alignment and/or land-take.

In those situations where large numbers of reptiles have been recorded, and the relevant areas cannot be avoided, prior to site clearance consideration should be given to whether an operation to remove reptiles from the 'footprint' of the works would be necessary. This would involve a combination of using the same techniques as for surveying reptiles to catch and move them, and cutting-back vegetation to remove cover and thus displace them. The installation of reptile-proof fencing to prevent reptiles from returning or accessing to the most hazardous parts of the construction site should also be considered. The seasonal programming of site clearance works should also be reviewed, to avoid the hibernation period during which aggregations of torpid reptiles could be encountered that would not have the ability to escape the works.

Where valuable reptile habitats would be removed as part of a road project, it will be appropriate to design the new roadside landscapes to be of value to reptiles, e.g. by incorporating small-scale variation in micro-topography and exposed substrates; making use of open, sustainable drainage structures that do not trap reptiles; creating artificial hibernacula; and designing a landscaping scheme that will develop mosaics of different vegetation types.

Reptiles are likely to negotiate larger underpasses or wide, short faunal tunnels that are largely dry, but longer dark, cold, damp tunnels are unlikely to be used for anything other than the most infrequent dispersal movements.

However, whilst reptiles might use some crossing structures on an incidental basis, this will only ever involve small proportions of road-side populations. Whilst roads can represent a source of incidental mortality through reptiles falling into drainage structures or being killed by traffic, it is not appropriate to install permanent reptile-proof fencing, since the value of the road-side habitats for reptiles will generally outweigh the hazards.

KEY CARD:
Viviparous lizard
(*Lacerta (Zootoca) vivipara*)

Viviparous lizard
(*Lacerta (Zootoca) vivipara*)
Photo: Malcolm Wray, Cresswell Associates

Description

The viviparous lizard is Ireland's only native lizard. Individuals vary significantly in colour, but usually have a predominantly brownish, sometimes greenish upper body, with a vertebral and two lateral lines of darker markings, commonly edged with white or yellow. The undersides are brightly coloured, generally yellow or orange and often with black markings. Newborn lizards are black, fading as they grow to bronze-brown on their upper surface and grey beneath. Adult lizards grow to approximately 15cm, roughly 60% of which is tail. A proportion of adults will have shed parts of their tails.

Life-Cycle and Behaviour

Viviparous lizards feed predominantly on invertebrates. They tend to emerge from hibernation in late-February/early-March and enter hibernation in late-October. There can also be some occasional activity in warm weather during the winter. This species gives birth to 4-10 live young, with a peak in late-July/early-August.

Habitat Preferences

Viviparous lizards are widespread and can be found in a range of habitat types. They reach highest densities in bog, heath and coastal habitats and the margins of coniferous woodlands. They also tend to be common in a range of grassland habitats, particularly those not subject to heavy grazing pressure, and can make use of gardens, other suitable features in built-up areas and post-industrial sites.

Within these habitats, lizards need access to the following features:

Basking sites: often on south-facing slopes and hedge banks or areas with micro-topographic variation, and with structurally-diverse mosaics of vegetation and exposed substrates.

Refuges: places of shelter including patches of dense vegetation, rock and soil fissures, log piles and mammal burrows.

Foraging areas: features with a high concentration of prey.

Hibernacula: free-draining structures, usually with a sunny aspect, including a similar range of features as are used as refuges (above).

As described for reptiles generally, many of these features will be found on existing road verges.

Survey Techniques

Surveys for viviparous lizards will be required where habitat features likely to be of particular importance for them have been identified during the multi-disciplinary walkover survey. In circumstances where habitats would be affected that would be likely to support relatively small numbers of viviparous lizards and where the species is likely widely distributed in the locality, it may be appropriate simply to assume the presence of the species and design mitigation accordingly. In certain situations, it may be possible to make incidental observations of viviparous lizards during the multi-disciplinary walkover survey itself.

For viviparous lizards, the key items of information that need to be collected in order to inform an EIS and design appropriate mitigation are: (i) the presence or absence of the species within habitats that will be directly affected by the works; (ii) assuming they are present, the distribution of lizards within the survey corridor; (iii) the apparent 'health' and viability of the lizard population (e.g. evidence of breeding in current or recent seasons and the proportion of animals carrying wounds or with missing tails); (iv) identification of potentially important features (e.g. hibernation sites); and (v) an assessment of the likely value of the different habitats in the survey corridor for lizards.

Whilst it can be helpful to make use of artificial refuges, direct observation-based surveys tend to be effective in detecting populations of viviparous lizards. Surveys should therefore begin with direct observations alone, only making use of artificial refuges as an additional measure when needed to provide the items of information listed above.

In order to reliably infer absence from a site (and to provide all of the information listed above) it would be necessary to repeat the survey visits between 5 and 10 times during appropriate weather conditions (see Group-Specific Survey Techniques) and during the months viviparous lizards are active. Clearly if all of the 'questions' can be answered in the first few visits, the surveys can be curtailed.

Optimum Survey Period

The best months in which to reliably find viviparous lizards are April to mid-/late-May, and mid-/late-August to mid-September, depending upon the weather conditions at the beginning and end of each period. Hazy or intermittent sunshine provides the most productive conditions during these periods, but bright sunshine early in the day in cool weather can also be suitable. Surveys are not appropriate during cold or wet periods within these months. The weather conditions within which effective surveys can be undertaken is set out in more detail in the GSGN for reptiles.

Mitigation, compensation and enhancement

Capture and relocation operations for this species can be extremely labour-intensive and in most cases the most efficient approach will be to cut down and rake-off vegetation during warm weather, with the intention of displacing the resident lizards prior to earthworks or other activities that could result in their incidental mortality. Whether or not reptile-proof fencing is then required to exclude the animals will need to be reviewed on a location-specific basis.

Key reference

- Beebee, T. and Griffiths, R., 2000. *New Naturalist No.87: Amphibians and Reptiles*. London: Harper Collins Publishers
- Highways Agency, Scottish Executive, Welsh Assembly Government, the Department for Regional Government Northern Ireland, 2005. *Design Manual for Roads and Bridges HA 116/05 Volume 10, Section 4, Part 7: Nature conservation advice in relation to reptiles and roads*. UK: The Stationery Office.

BIRDS
GROUP-SPECIFIC GUIDANCE NOTE

Group-specific Guidance Note: Birds

GENERAL CHARACTERISTICS OF THE GROUP

Birds are a diverse group: it is estimated that there are approximately 9600 species worldwide and, consequently, these animals exhibit a tremendous degree of diversity and variation.

Ireland supports comparatively fewer breeding bird species than other areas in Western Europe. This is due to the fact that, as an island, it is geographically separated from neighbouring land masses and, therefore, species that do not move over long distances (such as the marsh tit (*Parus palustris*) and willow tit (*Parus montanus*)) have failed to colonise from Britain. In addition, some habitat types do not occur in Ireland and birds associated with these (e.g. montane species such as ptarmigan (*Lagopus mutus*)) also do not occur here.

Nevertheless, Ireland's coastal and estuarine habitats represent a particular strong-hold for birds. Due to its location and relatively warm, wet climate during the winter months, Ireland attracts large numbers of wildfowl and waders. For example, The Wexford Nature Reserve Special Protection Area (SPA) supports over half of the world's Greenland white-fronted geese (*Anser Albifrons*).

Ireland also supports populations of some species which are in severe decline elsewhere in Europe. Most notably, conservation efforts are leading to population increases of corncrake *(Crex crex)* within the Shannon Callows, Connaught and Donegal. Ireland also supports the largest breeding population of storm petrels (*Hydrobates pelagicus*) in Europe, as well as significant breeding colonies of roseate tern (*Sterna dougallii*).

POTENTIAL IMPACTS OF ROAD PROJECTS

Road construction and operation can have various impacts on bird species and communities. These can include: habitat loss and degradation (e.g, through site clearance operations or increases in noise and visual disturbance); fragmentation of habitat (by severing habitats and landscape features of ornithological importance); direct disturbance (in particular, during critical periods of birds' lifecycles such as the breeding season) and direct mortality of individuals (both during site clearance and during the operational phase of a road project).

SURVEY TECHNIQUES

It is important to develop a clear suite of objectives prior to undertaking bird surveys. In view of the diverse range of bird species that are present in Ireland, any survey must be designed with care, in order to ensure that it is sufficiently thorough to answer specific questions without being unnecessarily costly or time-consuming.

The decision as to whether further bird surveys need to be carried out (and if so the type of survey methodologies that may be required), should be based on a combination of a comprehensive desk study, the habitat assessment undertaken as part of a multi-disciplinary walkover survey, supplemented by discussions with the relevant consultees. Further surveys should only be

undertaken in those situations where significant impacts are likely on important assemblages or populations of birds.

The following paragraphs provide a brief summary of standard survey techniques and the circumstances in which they can be applied. More detailed methodologies, including those for particular species of importance will need to be obtained from specialist literature (in particular, Gilbert *et al*, 1998;Bibby *et al*, 2000 and Hardey *et al*, 2006).

BREEDING BIRD SURVEYS

For most habitats, it will be appropriate to focus on breeding birds. Under normal circumstances, a survey of breeding birds would seek to determine: which species are present on a site; whether there is any evidence of breeding behaviour; and an estimation of the number of pairs present. In most cases, a 'scaled-down' survey protocol, based upon the specifications of the Common Bird Census (CBC) methodology will prove sufficient to address these survey objectives. For the purposes of environmental assessment, full scale CBC involving territory mapping and up to 10 visits is unlikely to be required. Three survey visits during the breeding season (April to June) starting one hour after first light and finishing wherever possible before 9am (and certainly by midday) should be sufficient. The survey area should be slowly walked in a manner that enables the surveyor to come to within 50m of all habitat features. Birds will need to be identified by sight and song; those seen and heard should be plotted on maps and sexes, ages, and breeding behaviours noted using the standard CBC notation.

WINTERING BIRD SURVEYS

Although wintering bird surveys may be required on sites supporting a variety of habitat-types, they are generally more commonly associated with wetland habitats. Winter bird surveys of terrestrial habitats can adopt a similar methodology to breeding bird surveys (see above), since they usually aim to identify the presence or absence of target species and an estimation of numbers of birds.

For most wetland habitats, an approach based upon the British Trust for Ornithology's (BTO's) Wetland Bird Survey (WeBS) methodology is appropriate. This survey type involves carrying out counts of wildfowl and waders within two hours of high tide (Core counts) and low tide (Low tide counts; with a distinction made between feeding and non-feeding individuals). Physical parameters such as weather conditions and the presence of any disturbance factors should also be noted. Large sites should be divided into sectors and counts should be made from vantage points wherever possible.

The decision whether to use core count or low tide count data will depend on the extent of existing data and the issues that need to be addressed. Specific surveys targeted towards individual species or groups may be required, depending upon the results of the desk study, earlier multi-disciplinary walkover survey and consultations.

Further information on WeBS and other specialist wintering surveys can be obtained from (Gilbert *et al*, 1998).

PASSAGE BIRD SURVEYS

Surveys to assess the importance of a site or route corridor for 'passage' waterbirds (during migrations) should be carried out using the WeBS methodology. Surveys for passage waterbirds should be carried out in March (one survey in mid- to late-March), April (two surveys), May (two surveys), August (two surveys) and September (two surveys).

Bird surveys should be sufficiently thorough to inform an appropriate level of impact assessment, without being unnecessarily costly or time-consuming. This should be achieved by employing trained, experienced ornithologists to carry out targeted field assessments (based on their extensive knowledge).

Further survey guidance in relation to hen harriers (*Circus cyaneus*) barn owls (*Tyto alba*) and large waterfowl (geese and swans) is provided on the following Key Cards.

MITIGATION, COMPENSATION AND ENHANCEMENT

Should road-related development or maintenance works result in an unavoidable impact on bird species, assemblages or communities of particular nature conservation importance, it will be necessary to devise an appropriate mitigation strategy, usually in consultation with the NPWS and other relevant consultees. This will preferably comprise the avoidance of the key habitat areas, if at all possible, but may also involve seasonal constraints on works (e.g. by timing those operations with the greatest potential to disturb nesting or over-wintering birds to take place outside these periods) and the minimisation of indirect effects (such as protecting the hydrology of adjacent wetland sites of importance to wintering birds).

One of the most effective measures to avoid the incidental disturbance or mortality of birds during construction is to, wherever possible, undertake vegetation clearance outside the bird nesting season, that is not during the period March to August inclusive (see Appendix III).

In order to be successful, mitigation measures require consideration at the project design stage. For example, careful consideration of the alignment of a new road can ensure that sensitive wetland sites supporting important assemblages of wildfowl and waders are avoided. Furthermore, the likelihood of barn owls suffering high levels of road traffic-related mortality during a road's operational lifetime can be minimised through the careful design of a landscape planting layout to 'guide' foraging and commuting owls away from the road's traffic zone.

Where it is unavoidable that bird species of nature conservation importance would be significantly affected by road construction or improvement works, it will be appropriate to consider habitat enhancement or creation measures to compensate for these effects, in order to maintain the conservation status of the bird populations concerned. The specific details of such mitigation, compensation and enhancement measures would need to be developed on a case-by-case basis (in consultation with the NPWS and other relevant consultees); however, they could include, for example: the enhancement of 'sub-optimal' habitats nearby, the translocation of habitat features of particular importance (such as hedgerows used by nesting birds), and compensating for the loss of natural nest sites through the erection of artificial nest boxes.

If it has not been possible to confirm the absence of an important bird species during the assessment process, and the site lies within the appropriate geographical range for bird and the habitat is suitable, a precautionary approach to mitigation should be adopted. Furthermore, mitigation measures should be proportionate to the importance of the bird population or assemblage that would be affected and the scale of the potential impacts upon them. A suitably experienced ecologist should also be present on site to oversee the mitigation, and to monitor the works to ensure that retained important bird habitats are protected.

Key reference

- Bibby, C.J., Burgess, N.D., Hill, D.A., & Mustoe, S.H., 2000. *Bird Census Techniques*. 2nd ed. London: Academic Press.
- Gilbert, G., Gibbons, D.W., & Evans, J., 1998. *Bird Monitoring Methods*. 1st ed. Birmingham: Spectrum Flair Press.
- Hardey. J. et al, 2006. *Raptors: a field guide to survey and monitoring*. 1st ed. Edinburgh: The Stationary Office.

KEY CARD:

Geese and Swans

Of the species of swans and geese that regularly occur in relatively large numbers across Ireland during the winter and/or migratory periods, the following species have been selected for further consideration within this Key Card: Greenland white-fronted goose (*Anser albifrons flavirostris*), the greylag goose (*Anser anser*), the barnacle goose (*Branta leucopsis*), the whooper swan (*Cygnus cygnus*), and the Bewick's swan (*Cygnus columbianus*). This is based on the additional levels of legal protection that they are afforded under the European Communities (Conservation of Wild Birds) Regulations, 1985 (as amended), see the GSGN for birds for more information.

Greenland white-fronted goose (*Anser albifrons flavirostris*)

Description

The Greenland white-fronted goose is a medium-sized, grey-brown goose, with orange legs, a long orange-yellow bill with a prominent white blaze around the base of the bill (in adult birds only).

Greenland White-fronted Goose (*Anser albifrons flavirostris*) Photo: Laurie Campbell

Life-Cycle and Behaviour

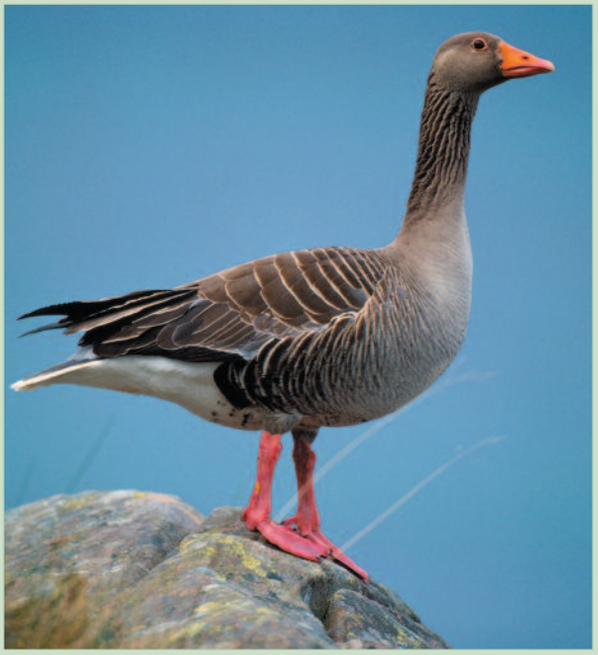
The species is a highly gregarious, winter migrant occurring in Ireland between October and April. In Ireland, its distribution is restricted, primarily occurring at the Wexford Slobs (up to 9,000 birds), with smaller numbers (several hundred birds) elsewhere. Additional important sites include: Tacumshin Lake and Cahore Marshes (Co.Wexford); Loughs Swilly and Foyle (Co. Donegal); Lough Gara and River Suck/Shannonbridge (Co. Roscommon); Midland Lakes (Loughs Derravarragh, Iron, Owel & Ennell) (Co. Westmeath) and Little Brosna (Co. Offaly).

Habitat Preferences

Greenland white-fronted geese graze on a range of plant material: they take roots, tubers, shoots and leaves in areas of bogs, dune grassland, and occasionally salt marsh. Their usage of agricultural grassland for grazing is currently increasing.

Greylag Goose
(*Anser anser*)

Description



Greylag Goose
(*Anser anser*)
Photo: Laurie Campbell

The greylag goose is a large, bulky, grey goose, with pinkish-orange bill and dull pink legs. Some birds have a thin white rim at the base of the bill, and many have dark marks on the belly. In flight, these birds can be distinguished by their striking pale forewings.

Life-Cycle and Behaviour

Gregarious in nature, this species over-winters in Ireland with birds arriving from Icelandic breeding grounds in November, and remaining at the wintering grounds until April (although feral birds are present all year round). Icelandic birds tend to occur in relatively large numbers (flocks numbering up to 3,000 birds, but usually in the low hundreds) at several main locations in Ireland, including: Lough Swilly in Co. Donegal; Braganstown in Co. Louth; Poulaphouca Reservoir in Co. Wicklow; Mountseskin/Gortlum in Co. Dublin; and the River Suir Lower in Co. Waterford. There are also many other sites that support feral birds throughout the country.

Habitat Preferences

Greylag geese are primarily associated with estuarine habitats, where they feed on the roots of sedges and rushes. However, over the last 50 years, they have also become accustomed to grazing on cereal crops and grasses.

Barnacle Goose

(*Branta leucopsis*)

Description

The barnacle goose is a medium-sized goose with a fairly long neck and a small, short bill. Its creamy coloured face contrasts boldly with its black crown, neck and breast. Its upperparts are barred grey, with paler underparts. The barnacle goose is distinguished in flight by the contrast between its black breast and whitish belly.

Barnacle Goose
(*Branta leucopsis*)
Photo: Laurie Campbell

Life-Cycle and Behaviour

This species winters in Ireland, primarily on isolated islands in the north-west of the country. It arrives from its breeding grounds in Greenland in October, remaining in Ireland until April. It is highly gregarious, forming large flocks, the largest of which tend to occur at the Inishkea Islands, Co. Mayo and at Ballintemple, Co. Sligo (each site supporting approximately 2,500 birds).

Habitat Preferences

This species prefers coastal grazing marsh during the winter months, grazing on a range of coastal grasses, including pasture land.

Whooper Swan
(*Cygnus Cygnus*)

Description

The whooper swan is larger than the Bewick's swan, with a longer neck and a yellow and black bill (the yellow area projects below the nostril). The whooper swan's plumage is all white and its call has a trumpet- or bugle-like quality.

Whooper Swan
(*Cygnus Cygnus*)
Photo: Laurie Campbell

Life-Cycle and Behaviour

The whooper swan arrives from its Icelandic breeding grounds in October, remaining in Ireland until April. During the winter, this species tends to be gregarious, with family members migrating to the Irish wintering grounds together as a group. Whooper swans are relatively widespread, in particular in the north and west of the country. The largest assemblages of these birds (numbering between approximately 400 and 2,000 individuals) occur at Lough Swilly and the River Foyle (Co. Donegal), Lough Foyle on the Donegal/Derry boundary, Lough Gara (Co. Sligo) and the Lough Oughter wetland complex.

Habitat Preferences

Whooper swans tend to occur around estuaries and other wetland sites, where they feed almost entirely on aquatic vegetation (leaves, stems and roots). However, in recent years, they have also been recorded in arable farmland, where they graze on grass and spilt grain, as well as potatoes from cultivated land.

Bewick's Swan
(Cygnus columbianus)

Description

Bewick's swan is an all-white and medium-sized swan, with a yellow and black bill which is yellow at the base, usually rounded or square, and not reaching the nostril or extending along the sides, which allows them to be distinguished readily from whooper swans. The neck is also shorter than that of the whooper swan.

Bewick's Swan
(*Cygnus columbianus*)
Photo: David Kjaer, Naturepl.com

Life-Cycle and Behaviour

The Bewick's swan is an over-wintering species from Arctic Siberia. Numbers in Ireland have declined from over 1,000 birds to less than 300 during the last swan census (2005). This species over-winters in Ireland between November and February and is found mostly at Tacumshin Lake and Wexford Slobs (approximately 200 birds) in Co. Wexford.

Habitat Preferences

During the winter, this species prefers lowland wetland sites with suitable grazing areas nearby. Bewick's swans feed on tubers, shoots and leaves from wetlands and within partially-flooded habitats.

All Goose and Swan Species

Survey Techniques

A desk study should be undertaken to confirm whether the road project is in close proximity to habitats and features that could be used by large numbers of geese and swans. In particular, the desk-based survey should seek to identify the presence of Special Protection Areas (SPAs) or Natural Heritage Areas (NHAs) within 10km of the proposals, which have been designated on the basis populations of geese and swans (as well as other species of waterbirds).

Depending upon the location of the road project, and the nature and significance of any nearby wetland sites, it is possible that goose and swan count data from the Irish Wetland Bird Survey (WeBS) may already exist. Where applicable, these data should be reviewed to identify whether they represent a sufficiently comprehensive baseline in relation to these birds. If so, this may negate the requirement to carry out novel surveys. However, the decision to rely on desk-based survey information alone should be taken in consultation and agreement with NPWS and other relevant consultees.

In most cases, field surveys for these geese and swan species would be expected to follow the WeBS methodology (as described within the GSGN for Birds). Further information can also be obtained from Gilbert *et al*. (1998).

In instances where swan and goose surveys are required in either terrestrial or non-tidal wetland habitats, counts should be undertaken using a 'look-see' methodology. This relies on the field surveyors walking around the periphery of such habitats using binoculars (and a telescope where necessary) to locate, identify and count flocks of water birds. Depending upon the nature of the site in question, it may be possible to undertake such counts from a concealed vantage point. Care should be taken not to disturb the birds, since this could result in them flying elsewhere and being double-counted.

If it is anticipated that the presence of swans and/or geese within terrestrial or non-tidal wetland habitats coincides with high tide events at a nearby estuary, or the onset of nightfall, the timing of the surveys should be modified accordingly to target the appropriate times of day. Further details of 'look-see' methodologies can be obtained from Bibby *et al*. (2000).

In addition, it would be appropriate during the multi-disciplinary walkover survey to identify habitats such as watercourses or other linear features which may constitute important flightlines for swans and geese, in particular, between wetland sites. These could be of particular importance during the migration period. Should these features be affected by the proposals, then it would be appropriate to undertake more detailed surveys, in the form of vantage point surveys. These should be undertaken during the winter, with a proportion of the survey effort being focussed at the beginning and end of the survey season, when birds are likely to be arriving and leaving as part of their annual migration.

Optimum Survey Periods

Greenland white-fronted goose – October to April (inclusive).

Greylag goose – November to April (inclusive).

Barnacle goose – October to April (inclusive).

Whooper swan – October to April (inclusive).

Bewick's swan – November to February (inclusive).

Mitigation, compensation and enhancement

For road projects affecting wetland sites supporting large numbers of swans and geese (particularly SPAs and/or NHAs), mitigation measures should be developed in consultation and agreement with NPWS and other relevant consultees.

The nature and extent of such measures will need to be adopted on a case-by-case basis. However, as a general rule, road construction projects should seek to avoid wetland sites supporting large assemblages of waterfowl (particularly SPAs and/or NHAs). Where this is unavoidable, works with the potential to disturb wetland bird should be timed to take place outside of the period when these birds are present. If disturbance cannot be avoided, measures to minimise any associated adverse effects should be developed. These could include, for example, the installation of visual and acoustic barriers to screen the birds from potential sources of disturbance.

In addition, crossings of important flightlines, such as a road crossing of a watercourse that links important sites for geese and swans, should be designed carefully to ensure that direct impacts on birds are avoided and any effects of fragmentation are minimised as far as possible. This should be reviewed on a case-by-case basis and could include the following: a review of options to avoid crossing the watercourse; the use of planting techniques to encourage birds to cross the scheme at a greater height than the 'live' carriageway; if vertical elevation allows, the use of clear-span structures to provide a continuation of the flightline. These measures should be developed in consultation with NPWS and other relevant consultees.

Mitigation measures should also seek to address indirect impacts on swans and geese. In particular, attenuation and pollution control measures should be implemented to protect water quality in the areas of importance for geese and swans, particularly their downstream foraging and bathing habitats used by swans and geese.

Whilst the creation of balancing ponds and attenuation basins (as part of the road drainage design) may confer secondary ecological benefits to wetland birds, they should not be used as like-for-like replacement of wetland features, since their primary role is to treat and attenuate polluted run-off from hard surfaces and, therefore, their suitability for use by wetland birds could deteriorate over time. It may also not be appropriate to seek to attract aggregations of waterfowl close to new roads. In addition, it is important to review the design of drainage options with the aim of avoiding future road deaths and road traffic hazards: the use by swans and geese of large open ditches running parallel to a road can cause problems associated with the birds mistakenly landing on the road during wet conditions.

Key reference

- Gilbert, G., Gibbons, D.W., & Evans, J., 1998. *Bird Monitoring Methods*. 1st ed. Birmingham: Spectrum Flair Press.

KEY CARD:
Hen harrier
(*Circus cyaneus*)

Hen Harrier (*Circus cyaneus*)
Photo: Laurie Campbell

Description

The hen harrier is a medium-sized raptor (bird of prey) with males being of a smaller size than females. It has long wings and tail, and will fly close to the ground, with wings raised in a shallow 'V' when soaring. Male and female adult plumages differ greatly. Adult males are blue-grey above and on the head and breast, with white underparts, contrasting with black outer primaries (outermost wing feathers) and a dark band along the trailing edge of the underwing. Female birds are largely brown with fine markings and an obvious white rump and banded tail.

Life-Cycle and Behaviour

Hen harriers can be both solitary and gregarious in nature, depending upon factors such as season and abundance of prey. Prior to and during the breeding season, males and females perform aerial display flights (Sky-dancing) within territories. The female usually lays 4 to 6 eggs from April to late-May. Hen Harriers mainly feed on song birds, young waders and small mammals. Outside of the breeding season, hen harriers tend to be less sedentary and will use communal night-roosts, generally within rank vegetation on the ground. The hen harrier is considered to be resident within parts of Ireland and a partial migrant (with wintering numbers being elevated by the arrival of birds from Britain). Hen Harriers are primarily found in the following counties: Laois, Tipperary, Cork, Clare, Limerick and Kerry.

Habitat Preferences

During the breeding season, hen harriers tend to prefer moorland habitats for nesting and foraging; however, young forestry plantations will also be used. Infrequently, mature forestry plantations and grassland habitats may be used, provided that there are sufficient open areas for hunting nearby. In winter, birds disperse over upland areas, farmland, wetland sites (such as reedbeds) and coastal lowlands.

Survey Techniques

A desk study should be undertaken to confirm whether the scheme is within the hen harrier's geographical range during the breeding and/or wintering periods. Where this is the case, existing

records of this species should be sought up to 10km from the proposed route corridor. In particular, the desk-based survey should seek to identify the presence of Special Protection Areas (SPA) or Natural Heritage Areas (NHA) within 10km of the scheme, which have been designated on the basis of hen harrier populations. The need for further surveys should be determined on the basis of an assessment of the suitability of the habitats and any incidental records collated during the multi-disciplinary walkover survey, along with consultations with the NPWS and other relevant consultees.

Methodologies for undertaking field surveys for hen harriers are described in detail by Gilbert *et al*. (1998) and Hardey *et al*. (2006). Summaries of the field survey methods are set out below:

Breeding season surveys

At least two survey visits are required between early-April and the end of May. If breeding is not confirmed, a third visit should be undertaken between late-June and the end of July.

During the first visit, all areas that are suitable for hunting and nesting harriers should be mapped, through a combination of observations from vantage points and by walking to within 250m of all parts of the route corridor.

During the second visit, all areas previously identified as represented suitable hunting and nesting habitats should be surveyed, recording all hen harrier observations and an attempt should be made to confirm breeding by observations from suitable vantage point sites located at a distance from potential nest sites.

If breeding is not confirmed, or if it is considered likely that the site may support a larger number of breeding pairs then already identified, then a third survey visit should be carried out between late-June and the end of July. This should entail observations from vantage points located at a distance from potential nest sites to watch for birds and locate any nests that may previously have remained undetected.

Surveys outside of breeding season

Surveys outside of the breeding season should seek to confirm whether the survey area supports communal hen harrier roost sites. This can be achieved by undertaking observations of harriers in the late-afternoon and watching them fly back to the roost site. Alternatively, watches for birds leaving the roost site can be undertaken at first light. Watches should be made from suitable vantage points located at a distance from the potential roost site.

In addition, it would be appropriate during the multi-disciplinary walkover survey to identify habitats such as watercourses or other linear features that may constitute important flightlines for hen harriers, in particular, between hunting and breeding sites. These are likely to be of particular importance during the migration period. Should these features be affected by the proposals, then it would be appropriate to undertake more detailed surveys, in the form of vantage point surveys. These should be undertaken during the winter, with a proportion of the survey effort being focussed at the beginning and end of the survey season, when birds are likely to be arriving and leaving as part of their annual migration.

Optimum Survey Period

Hen harrier surveys are seasonally constrained. Breeding season surveys should be undertaken between early-April and the end of May, whilst winter season surveys involve monthly visits between October and March inclusive.

Mitigation, compensation and enhancement

Appropriate mitigation measures for hen harriers should be developed on a site- and project-specific basis. Road schemes should make every effort to avoid hen harrier nesting and roosting sites. Where this is not possible, site clearance and construction works at nest sites should take place outside of the birds' breeding season. Works in the vicinity of roosting sites should take place outside of the winter months. Since hen harriers are not known to use artificial nest boxes, the use of such structures as a mitigation technique is not valid.

During the breeding season, harriers tend to forage along habitat edges. The route of the road scheme should aim to avoid bisecting edge features, to minimise these birds' potential collision risks. Where edge features are bisected, both on-site and off-site planting strategies should be used to encourage the foraging harriers to fly perpendicular to the road, and to discourage them from crossing the 'live' carriageway.

In addition, crossings of important flightlines, such as a road crossing of a linear habitat linking hunting and breeding sites, should be designed carefully to ensure that direct impacts on birds are avoided and any effects of fragmentation are minimised as far as possible. This should be reviewed on a case-by-case basis and could include the following: a review of options to avoid crossing the feature; and, failing that, the use of planting techniques to encourage birds to cross the scheme at a greater height than the traffic. The mitigation methods used should be agreed in consultation with NPWS and/or other relevant consultees.

Key reference

- Gilbert, G., Gibbons, D.W., & Evans, J., 1998. *Bird Monitoring Methods*. 1st ed. Birmingham: Spectrum Flair Press.
- Hardey. J. et al, 2006. *Raptors: a field guide to survey and monitoring*. 1st ed. Edinburgh: The Stationary Office.

KEY CARD:

Corncrake (*Crex crex*)

Description

Corncrakes are shy, secretive birds that are rarely observed. They have bright chestnut wings and inner flight-feathers, and grey to yellow-buff feathers elsewhere, with dark markings on their back. In flight, the legs dangle characteristically. Corncakes tend to extend the head above cover periodically, and males hold this distinctive pose when making their loud, grating and repetitive "kerrx-kerrx" sound.

Corncrake (*Crex crex*)
Photo: Laurie Campbell

Life-Cycle and Behaviour

The corncake is a summer visitor to Ireland, arriving from sub-Saharan Africa in April and leaving in September. Once a relatively common visitor across Ireland, they are now present in small numbers in the Shannon Callows, north Donegal and western parts of Mayo and Connaught. They are solitary except in the breeding season (and occasionally during migration) when pairs or family groups are seen. They breed from mid-May to early-August, nesting on the ground in hay meadows, and second clutches are commonly laid. Nests consist of a shallow cup or swirl of grass on the ground, lined with dead leaves and sometimes with stems pulled together over the top to form a canopy. They feed largely on insects, although other invertebrates such as slugs and snails are also taken, as are plant material including seeds of grasses and sedges.

Habitat Preferences

Corncrakes traditionally inhabit hay meadows, which tend to provide them with abundant foraging resources. The will also make use of silage fields. Gardens, nettlebeds, crops and other vegetation may also be used. They require cover up to head height, and avoid open habitat and tall, dense vegetation. Tall marsh vegetation is used for cover on arrival in spring, before meadow grasses become long enough for corncrakes to use. Corncakes tend to nest towards the centre of fields, in concealing tussocky vegetation, and also make use of un-mown areas and field-margins. The conversion of hay meadows to silage fields, and mechanisation of the hay-making process has played a massive role in the decline of this species. Regular or early mowing of meadows destroys nests and leads to high chick mortality. Increases in sheep-grazing, which results in short grass unsuitable for use by corncrakes, has also contributed to their decline.

Survey Techniques

A desk study should be undertaken to confirm whether the road project is in or close to the corncrake's known geographical range. Recent records of their distribution within and up to 5km from the route corridor should be obtained (as their range has contracted rapidly during the last 100 years, historical records are unlikely to be useful). In particular, the desk-based survey should

seek to identify the presence of Natural Heritage Areas (NHA) within 5km of the scheme that have been designated on the basis of corncrake populations.

An initial habitat assessment should be carried out during the multi-disciplinary walkover survey to determine the suitability of features within the route corridor for foraging and nesting corncrakes; surveyors should highlight, in particular, long-established grassland likely to be traditionally managed for hay, along with other potentially suitable habitat features, as identified above.

Methodologies for undertaking field surveys for corncrakes are described in detail by Gilbert *et al*. (1998). A summary of the field survey method is set out below:

At least two survey visits are required between the 20th May and the 30th of June, undertaken between midnight and 3.00am BST. Licences would not normally be required to undertake surveys of this kind, but this should be reviewed with NPWS on a site-specific basis. A route should be planned during a daytime visit to the site, taking the surveyor within 500m of all potential corncrake habitat. The survey route should be walked during the night, with regular stops to listen for singing males. Triangulation should be used to work out the location of the bird, and these should be recorded.

This survey methodology has been designed for use in annual monitoring schemes, and will need to be adapted prior to use to provide baseline information for an EIA for a road scheme, in consultation with NPWS and Birdwatch Ireland.

Optimum Survey Period

Two surveys to confirm the presence of corncrakes should take place between 20th May and 30th June.

Mitigation, compensation and enhancement

Mitigation should be developed on a site- and project- specific basis (ideally in consultation with NPWS and other relevant consultees). Where it is not possible to avoid key breeding habitats altogether, small-scale variations in alignment or profile should be considered, as well as the possibility of minimising land-take, in order to avoid the particular features likely to be important for this species.

The route of new schemes should aim to bisect as few traditionally managed hay meadows as possible. Where impacts on potentially suitable habitat features (in areas where corncakes are likely to occur) are unavoidable, measures should be taken to off-set these impacts through improvements in the management of alternative sites nearby, to benefit corncakes.

Key reference

- Gilbert, G., Gibbons, D.W., & Evans, J., 1998. *Bird Monitoring Methods*. 1st ed. Birmingham: Spectrum Flair Press.
- Mc Devitt, A.-M. and Casey, C., 1998. The Corncrake (*Crex crex*) in Ireland. In Schäffer, N. and Mammen, U., eds. *Proceedings International Corncrake Workshop 1998, Hilpoltstein/Germany*. Germany: Hilpoltstein, 1998.

KEY CARD:

Barn Owl

(*Tyto alba*)

Barn owl
(*Tyto alba*)
Photo: Laurie Campbell

Description

The barn owl is the only white owl likely to be seen in Ireland. At rest it appears mainly golden brown. The white, heart-shaped face and dark eyes of the barn owl are particularly distinctive. The barn owl appears long-necked with a short tail in flight. The white underparts contrast with the buff and light grey back.

Life-Cycle and Behaviour

Barn owls can remain with the same partner for life, and the female can lay between four and seven eggs between March and August. They are nocturnal birds, mainly active at dawn and dusk, hunting small mammals. In Ireland, the most abundant prey items are wood mice and brown rats; they will occasionally take birds and amphibians. The call of the barn owl is a long 'screech'; it also 'hisses', 'snores' and 'barks'. It is a resident species, breeding over much of the country. The population is estimated to be somewhere between 600 and 900 pairs, and is in steady decline.

Habitat Preferences

The barn owl is found on farmland and in low-lying areas. Open areas of tussocky grassland which include hedgerows, dykes and woodland edges provide good quality foraging habitat for this species. Roadside landscapes also constitute suitable foraging sites, as they can provide uninterrupted rough grassland supporting large populations of small mammals. The use of suitable roadside landscapes for dispersal and foraging by the barn owl, and its low flight over the ground make this species particularly vulnerable to collisions with vehicles. Barn owls also require undisturbed, dark, daytime roost and nest sites, typically in buildings and hollow trees.

Survey Techniques

A desk study should be undertaken to confirm whether the road project is in the barn owl's geographical range. Records for their distribution within and up to 5km from the route corridor should be obtained.

An initial habitat assessment should be carried out during the multi-disciplinary walkover survey to determine the suitability of the route corridor for foraging, nesting and roosting barn owls; surveyors should look for rough tussocky grassland likely to support high numbers of small mammals (prey items) and suitable nesting or roosting sites. Further surveys should only be carried out if particularly valuable habitat features likely to be used by an important local population of owls would be affected, or if potentially suitable nest or roost sites cannot be avoided.

To determine whether barn owls are using habitats and landscape features whilst hunting, direct observation surveys can be carried out throughout the year, but should always be carried out around dusk and or dawn when barn owls are most active. Surveyors should concentrate their efforts along linear features that provide suitable foraging habitat (hedges, edges of ditches, field margins, and lines of trees) where owls will be flying low and hunting.

Evidence of occupation of potential nest/roost sites (e.g. in old buildings, hollow trees and nest boxes) in close proximity to the road scheme should be investigated during winter. The area surrounding the potential nest site should be searched for field signs including pellets, droppings and feathers. Given their protracted breeding season and that barn owls will roost in buildings and trees throughout the year, it may be possible to confirm their presence at other times of year. If it is necessary to confirm whether or not barn owls are using a nest in a given year, further surveys should be carried out between June and mid-July at the peak of the breeding season; surveys should be avoided during March and April, when they are most susceptible to disturbance. Up to three visits may be required to determine the presence of breeding birds. The need for a licence to undertake surveys during the breeding season should be reviewed with NPWS.

Optimum Survey Period

Activity surveys, along with surveys to confirm evidence of roosting/nesting can be conducted all year round. However, surveys to confirm breeding are seasonally constrained and should take place between early June and mid-July.

Mitigation, compensation and enhancement

Mitigation should be developed on a site- and project- specific basis (ideally in consultation with NPWS and other relevant consultees). Where it is not possible to avoid key foraging habitats, small-scale variations in alignment or profile should be considered, as well as the possibility of minimising land-take.

The route of new schemes should aim to bisect as few linear features as possible, to minimise future collision risk. Locations at which linear features are bisected, or where obstacles occur within barn owl flight paths along road verges (such as bridges and sign gantries) should be identified and targeted for specific landscape planting treatments to avoid these areas becoming 'blackspots' for owl mortality. Sensitive landscape treatments to mitigate for this could include:

(a) the planting of tall hedgerows and/or tree lines in close proximity to the carriageway to encourage owls approaching and crossing the road to do so at a greater height than the 'live' carriageway;

(b) planting trees and scrub within sections of verge that approach potential obstacles at an angle, so that these features 'guide' foraging owls into off-site habitats, away from obstacles which would otherwise force these birds into the traffic.

In those situations where the loss of a nesting/roosting site would be unavoidable, works should be delayed until the last dependant nestling has left the nest. Nest sites should be replaced by several suitable nest boxes within the likely home range of the pair being affected, but ideally not within 1 km of a motorway or dual carriageway. Nest sites in the construction area should be made unusable after the breeding season, prior to work on the site.

Key reference

⊙ English Nature, 2002. *Barn owls on site*. Peterborough: English Nature.

KEY CARD:
Kingfisher
(*Alcedo atthis*)

Description

Kingfisher (*Alcedo atthis*)
Photo: Laurie Campbell

Kingfishers are unmistakable bright blue and orange birds of slow moving or still water habitats. The face and neck are a pattern of orange, blue and white, and the underparts are chestnut to orange. It is a small bird with a long bill and red feet, and is often noticed by its distinctive, shrieking call prior to seeing a flash of brilliant blue flying along a water-course.

Life-Cycle and Behaviour

Kingfishers show territoriality all year round, with a breeding pair often dividing their breeding territory between them during the winter months. Clutches of six to seven eggs are laid from late-March or early-April, with one or two broods usually raised. They are active during the day, feeding largely on freshwater fish (although aquatic insects, marine fish and other food sources are occasionally used), which they take from the water by accelerated plunging from a perch or from a hovering position. The population is estimated to be between 1300-2100 pairs, and is believed to have declined since the 1970s.

Habitat Preferences

Kingfishers tend to be found close to still or gently-flowing lowland freshwater, including rivers, streams, lakes, ponds, canals, docks and flooded gravel pits. They will use coastal areas and estuaries out of the breeding season. These birds require a constant food supply as well as an availability of feeding perches within their territories. Nesting burrows tend to be excavated in steep-sided, soft earth banks, along shady sections of watercourse. Nesting burrows are typically 45-90cm in length. The kingfisher is a resident species, breeding over much of Ireland, although its distribution is fragmented particularly during the breeding season. Their range covers a larger area out of the breeding season.

Survey Techniques

A desk study should be undertaken to confirm whether kingfishers have previously been recorded from watercourses in the vicinity of the road project. Records for their distribution within and up to 5km from the route corridor should be obtained.

An initial habitat assessment should be carried out during the multi-disciplinary walkover survey to determine: (i) the suitability of water features and associated habitats within the route corridor for foraging, nesting and roosting kingfishers; and (ii) whether nest holes indicative of nesting

activity in previous years are present. Ideally, this should be undertaken during the winter months, prior to the watercourse embankments becoming obscured by vegetation.

Further surveys should be undertaken if highways proposals would affect sections of watercourse embankment that could provide nesting locations for kingfishers (and in particular, if evidence of previous nesting attempts by these birds is recorded), as well as particularly valuable feeding areas (such as slow moving sections of watercourse with over hanging branches). The extent of watercourse to be surveyed should be proportionate to the scale of the proposed highway works, (i.e., the survey area should be sufficiently extensive to accommodate all suitable nesting habitat which could be subject to potentially damaging effects (e.g. habitat loss, noise, vibration, visual disturbance etc)).

Kingfisher territories tend to cover at least 1km of watercourse. Therefore, for most major highways projects, it is recommended that surveys extend at least 500m upstream and downstream of the works footprint (where suitable habitat exists).

Targeted surveys for this species should be carried out over at least four visits throughout the course of their breeding season (March-early July). The first of these should take place in mid March, to coincide with when birds are establishing breeding territories and undertaking nest burrow excavations. During this visit, features likely to be of importance to kingfishers (such as feeding perches, potential rest sites etc.) should be noted. During subsequent survey visits, the survey area should be walked at a slow pace and all kingfisher activity recorded. In addition, sections of watercourse bank which appear potentially suitable for use by nesting kingfisher should be watched from a concealed vantage point, to avoid disturbing nesting birds. Individual watches of potentially suitable nest locations should be undertaken over a duration of two hours, and should focus on the periods shortly after dawn and prior to dusk (i.e. when peaks in kingfisher activity tend to occur).

Optimum Survey Period

Surveys should be undertaken over a minimum of four visits, between March and July (inclusive).

Mitigation, compensation and enhancement

Where proposals would lead to the loss of a historic nesting location, consideration should be given to re-aligning the footprint of the works to avoid the loss of this site. Where this is not possible, site clearance works should be undertaken outside of the birds' breeding season (i.e. not during March to July inclusive). Given that broods often 'overlap', it is generally not possible to undertake bank-side works between broods. The loss of any (potentially suitable) nest sites should be compensated by the creation of an artificial nest site along adjacent sections of watercourse and within the breeding territory of the birds in question. This may require small-scale river engineering works to create a steep-sided section of river bank, with an absence of dense vegetation, into which kingfishers can excavate nesting burrows; north-facing nest sites are generally preferred. In addition, if the proposal involve the loss of a historic nesting site, it may also be appropriate to install an artificial nesting tunnel and chamber. The provision of new nest sites will require consultation with relevant authorities, including, NPWS and Fisheries Board.

Any works which could indirectly affect nesting kingfishers through increased levels of noise, vibration and visual disturbance should be timed to occur outside of the birds breeding season (see above).

National road scheme proposals in the vicinity of watercourses should include appropriate pollution control measures to ensure that the birds' foraging resources are safeguarded.

Other enhancement and compensatory measures include delivering improvements to the quality of foraging resources through, e.g. the creation of additional water features to provide supplementary feeding opportunities, as well as the installation of replacement feeding perches.

Key reference

- Snow, D.W. and Perrins, C.M., 1998. *The Birds of the Western Palearctic Concise Edition Volume 1 Non-Passerines*. Oxford: Oxford University Press.
- Hopkins, L., 2001. *Best Practice Guidelines Artificial Bank Creation for Sand Martins and Kingfishers*. Swindon: The Environment Agency.

MAMMALS
GROUP-SPECIFIC GUIDANCE NOTE

Group-specific Guidance Note: Mammals

GENERAL CHARACTERISTICS OF GROUP

As a group, mammals contain perhaps the most instantly recognisable species, and therefore often attract a disproportionate amount of attention and survey effort in comparison to their conservation status.

Mammals have adapted to most habitat types found in Ireland and therefore their distribution is largely dependent upon the type and location of habitats with which the individual species are typically associated. For example, otters are most likely to be encountered during road projects affecting watercourses, while other mammals associated with marine habitats such as, for example, dolphin, porpoise and seals will rarely be an issue for road projects. Some species are found in a wide range of habitat types. The variation in mammal species and the habitats in which they are found within the terrestrial environment makes a group-wide description particularly difficult. They range from the very small, such as pygmy shrews, to the very large, such as red deer. Ireland also supports a diverse assemblage of bats, with 10 species found within suitable habitats across Ireland.

Despite the diversity of habitats within which mammal species can be found, those environments subject to least disturbance by humans are likely to support the most abundant populations of mammals.

POTENTIAL IMPACTS OF ROAD PROJECTS

The principal impacts of road projects on individual mammal species depend on the ecology and behaviour of the species in question. All animals, regardless of behaviour, will be subject to a degree of habitat fragmentation. Smaller mammals such as the pygmy shrew and red squirrel will tend to have smaller home ranges, and will therefore be susceptible to both habitat loss and fragmentation. Larger or more mobile species may find their territories and key habitats fragmented by new roads or road widening projects, but are less likely to experience significant habitat loss. Mortality of species, both during the construction and operational phases of schemes, should also be considered during the assessment of impacts of road schemes on mammal populations, particularly for those species with large home ranges that will tend to seek to cross roads most often.

The construction of new roads also provides opportunities for the enhancement and protection of habitats for mammal species of nature conservation importance, in particular those species which can safely forage within and inhabit road verge and landscape planting areas created during road projects. In particular, it is important to review opportunities to manage road verges in a sensitive manner where this can be of value to mammal species (and the species that prey upon them), although any such scheme must be carefully reviewed to ensure it does not bring the target species or any other vulnerable species into contact with the road scheme, for road safety, animal welfare and nature conservation reasons.

SURVEY TECHNIQUES

The findings of the desk study and the multi-disciplinary walkover survey should be used to inform the requirements for further targeted surveys for particular species of mammal, supplemented by reviews with the NPWS and other relevant consultees. There is no single survey technique that can be applied to all Irish mammal species due to their diverse life-cycles, behaviour and habitat requirements. The multi-disciplinary walkover should seek to identify suitable areas of habitat that might support protected mammals in addition to recording any field signs such as well-used pathways, droppings, places of shelter and features or areas likely to be of particular value as foraging resources. In particular, given that they could represent constraints throughout the corridor of a scheme, badger setts and potentially suitable bat roost sites should be recorded during the multi-disciplinary walkover, along with potential otter holts and pine marten den sites wherever possible. In addition, since targeted surveys for them are unlikely to be undertaken, particular attention should be paid to the suitability of the habitat for pygmy shrew, hedgehog, hares, Irish stoat and pine marten, along with incidental observations of hares wherever possible and searches for pine marten scats.

Subsequent targeted surveys may be necessary in those situations where there could be significant impacts on the species listed above. Specific survey techniques for red squirrels, badgers, otters, pine marten and deer are described on the Key Cards which follow this GSGN, since these are the species for which specific surveys will most often be required. No Key Card has been produced for bats as the NRA has already produced comprehensive guidance on bat survey and mitigation: '*Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes*' and '*Guidelines for the Treatment of Bats during the Construction of National Road Schemes*'. Similar advice also exists for otters and badgers during the construction of National Road Schemes, and therefore the Key Cards for these species should be read in conjunction with this advice.

Road projects will generally not involve significant impacts on populations of the other protected mammal species, nor are there particularly relevant/effective mitigation measures specific to any of these species. Thus, in most cases, further surveys of, e.g. hedgehog or Irish hare, over and above the information collected during the walkover survey, will not be appropriate. In those few situations where significant impacts are likely, e.g. where grassland supporting large numbers of Irish hares would unavoidably be bisected, any further surveys should be designed on a case-by-case basis, following other published survey techniques and should be developed in consultation with the NPWS and other relevant consultees.

If the presence of a protected species of mammal is confirmed, in some circumstances, it may be necessary to undertake additional surveys to better understand the relative importance of the population and/or habitat features to be affected. This will help to more accurately assess the significance of the impact on the species and will assist in subsequent mitigation design. Guidance on these more detailed surveys are presented on the appropriate Key Cards, but it is always necessary, before undertaking more detailed surveys, to review the nature of the impact on the species and ensure that the level of survey is proportionate to the likely level of impact.

Multi-disciplinary walkover surveys should, as indicated in Section 4.2, always be undertaken by an ecologist with sufficient expertise to be able to accurately identify field signs of the target mammal

species. Care should be undertaken when arranging specific surveys for protected mammal species, as survey techniques involving trapping animals or activities that will result in their disturbance may need to proceed under licence. Similarly, the results of many more detailed surveys, such as bait-marking for badgers, will require particular expertise to be interpreted correctly.

MITIGATION, COMPENSATION AND ENHANCEMENT

Given the diverse life-cycles, behaviour, and habitat requirements of the different mammal species found in Ireland, effective mitigation, compensation and enhancement measures should be designed on a species-specific, and also site- and project-specific basis. It is important to take measures to avoid impacts on habitats likely to be of particular value to mammal species of nature conservation importance wherever possible. Where valuable habitats or other important sites for mammals (e.g. places of shelter, or key foraging resources) cannot be avoided, appropriate mitigation measures should be designed and implemented. Where impacts associated with fragmentation are expected, mitigation may include the provision of safe crossing points to enable dispersal and maintain links between otherwise fragmented populations, and to reduce future road mortality and improve road safety. Such crossing points may take the form of pipes, culverts, tunnels and bridges with associated mammal-resistant fencing to 'funnel' animals towards these structures.

Mammal-resistant fencing along with appropriate hedgerow treatments should be used as a barrier to guide animals towards safe crossing points and to prevent animals from straying onto the carriageway, reducing the risk of mammal mortality as a result of road traffic collisions and protecting road users. Visual deterrents such as roadside reflectors may also be installed to discourage deer, in particular, from approaching the carriageway, although the effectiveness of such measures is questionable and should only be used in areas where only occasional interaction between mammals and roads are expected.

Other mitigation techniques include the provision of artificial places of shelter to replace those that have been lost, the sequential clearance of habitats to displace animals from the footprint of the road project and, for certain species, the capture and translocation of individuals to pre-prepared receptor sites. The translocation of animals should be considered a last resort.

Opportunities should also be considered to replace lost habitats or develop new habitats of value to a range of mammal species, within the roadside landscape and other areas of landscape planting or field remnants associated with the road project. This could include designing landscape treatments to create new foraging habitat or places of shelter. However, any such proposals may also increase the frequency with which the intended species may come into contact with the road and potentially increase road-related mortality. Therefore, enhancement and mitigation opportunities on any scheme should be carefully reviewed in parallel with the proposals for mammal-resistant fencing and safe crossing points.

Given that, as identified under 'Survey Techniques', certain protected mammal species, Irish hares, for example, will routinely not be the focus of specific surveys, consideration should be given to incorporating enhancement measures as suggested above, on a precautionary basis, to help off-set any low-level residual impacts upon them.

KEY CARD:

Red Squirrel

(*Sciurus vulgaris*)

Red Squirrel
(Sciurus vulgaris)
Photo: Laurie Campbell

Description

The red squirrel is considered native to Ireland, although it has colonised the island several times since the last ice age. A particular distinguishing feature of red squirrels is their long ear-tufts. They have chestnut-red fur with a white/cream underside, and a red-brown to cream bushy tail. In the early winter, outside of the breeding season, the fur becomes thicker and greyer or dark brown in colour. Red squirrels are smaller than the introduced grey squirrel.

Life-Cycle and Behaviour

Red squirrels do not hibernate, although they are less active during winter and in poor weather. During the summer, there are peaks of activity in the morning and afternoon. During winter, there is a single peak in activity during the early morning. By comparison with the grey squirrel, red squirrels are highly arboreal (tree-dwelling), often reluctant to move over the ground for any distance. They feed in the woodland canopy, largely on hazel nuts, the cones of coniferous tree species, shoots and bark. The breeding season extends from December to September, with young born between late-February and early-April. Mating occurs during late-December to February and from March to May. The red squirrel's drey (nest) is a ball-shaped construction of bundles of dry twigs, or an adapted bird's nest, lined with finer material such as mosses and leaves. It measures approximately 300mm in diameter and tends to be located approximately 6m above ground, at a fork in tree branches, close to the trunk.

Habitat Preferences

Red squirrels are most commonly found in large blocks of coniferous woodland, although they may also be found in broadleaved/mixed woodland and scrub habitats where grey squirrels are absent. Woodland/scrub present in close proximity to road verges may be used by red squirrels where suitable habitat adjoins it, and these may act as habitat links to adjacent, otherwise isolated, blocks of woodland. In broadleaved habitats, red squirrels are usually displaced within 15 years of the arrival of greys, appearing to suffer competitive exclusion by a species better adapted to conditions in fragmented woodlands where acorns are often the principal food, or by contracting squirrelpox virus, which tends to be spread by grey squirrels. Even small numbers of broad-leaved trees present within or adjacent to coniferous woodland can nevertheless provide grey squirrels with 'access corridors' and sufficient resources to become established and subsequently displace the resident red squirrel. In Ireland, there are some areas of 'red squirrel refuges'. For

example, to the west of the River Shannon and in the south-west of Ireland, which to date have remained free from grey squirrel colonisation.

Survey Techniques

Following the desk study and multi-disciplinary walkover survey, if it is considered likely that there would be a significant effect on red squirrels, further targeted surveys may be necessary to confirm the presence of the species, and/or to collect information to inform a comprehensive impact assessment. A combination of three survey techniques should be used to determine the presence/absence of red squirrels: direct observation surveys; drey counts; and searching for feeding remains.

Direct observation surveys require the ability of the surveyor to distinguish reliably between red and grey squirrels. A series of transect lines should be walked through suitable habitat at a density of approximately one line per 10-20ha and between 500 and 1000m in length. Every 100m, all squirrels observed should be recorded, including time, location and behaviour. Standardisation of transect lengths is important where data are to be compared. Wherever possible, incidental observations of red squirrels will already have been made during the multi-disciplinary walkover survey.

Drey counts can be used to confirm presence of red squirrels and can also give an indication of population size (although it should be noted that dreys are semi-permanent and may persist for a number of years). Drey counts are less visible in dense habitats such as young conifer crops. In deciduous woodland, dreys are easiest to find in winter. It is not possible to differentiate reliably between the dreys of red and grey squirrels, and so where both species are present drey counts are difficult to interpret. Again, squirrel dreys will already have been recorded wherever possible during the multi-disciplinary walkover survey. However, they may be obscured when trees are in leaf and therefore drey searches may need to be repeated during the winter in deciduous woodlands.

Searching for feeding remains is useful when only red squirrels are present in a woodland. (It is not effective where both species are present because it is not possible to differentiate the feeding remains of the two species). There are two different techniques: exhaustive searches for feeding remains within likely features, or undertaking feeding remains transects. Feeding remains transects are carried out by collecting all eaten and uneaten conifer cones within a series of 50m by 1m transect lines, at a density of one transect per four hectares. Such a structured approach can provide information on timing and spatial distribution of conifer seed availability, habitat use, and squirrel density.

If, after carrying out a combination of direct observation surveys, drey counts and searching for feeding remains, the presence of red squirrels remains equivocal, it would be appropriate to undertake a hair tube survey. Baited tubes, lined with sticky tape, should be attached to tree branches at a height of 2-3m. Tubes should be checked within 7-14 days and any hair captured should be removed and identified. It is important to note that if hair tube surveys are carried out where both squirrel species are present, they may serve as a point of disease transmission and so should be used with caution.

Optimum Survey Period

It is possible to undertake direct observation and drey count surveys at any time of year. Direct observation produces the most reliable results when undertaken during the periods when squirrels are most active. Therefore, surveys should be carried out in the early to mid-morning (supplemented by inspections at dusk) when the majority of red squirrels are likely to be out of their dreys, throughout the summer. Periods of inclement weather should be avoided. Surveys in deciduous woodland are likely to be most effective during winter or early spring, because squirrels and their dreys tend to be more visible.

Mitigation, compensation and enhancement

Habitat loss and fragmentation is a major factor in red squirrel population declines, and steps should be taken to minimise the effects of the road project through small scale realignments and the retention of strategically important habitat links. Where avoidance of impacts is not possible, compensation should focus on the creation of woodland habitat, incorporating a diverse range of coniferous species alongside small-seeded broad-leaved species. Plantings should seek to establish new linkages and connections at the landscape scale, and the planting mix should maximise foraging opportunities for red squirrels and minimise those for greys.

Artificial dreys (nest boxes) can be provided, and the provision of safe crossing points, such as rope bridges, can be considered to minimise the risk of mortality as a result of road traffic collisions, although the efficacy of rope bridges in particular (especially when larger distances need to be bridged) remains unproven. Unoccupied dreys located in trees to be affected by site clearance operations should be removed, with trees felled during mid-October to January, when there is least chance of encountering young squirrels.

Key reference

- Gurnell, L.J. and Lurz, P.W.W., eds., 1997. *The Conservation of Red Squirrels, Sciurus vulgaris*. London: People's Trust for Endangered Species.
- Gurnell, L.J., Lurz, P.W.W., and Pepper, H., 2001. *Practical Techniques for Surveying and Monitoring Squirrels*. Edinburgh: Forestry Commission.
- Lawton, C., ed., 2005. *Proceedings of the Irish Red Squirrel Conservation Symposium, 22nd April, 2005*. Galway: National University of Ireland.
- Pepper, H. and Patterson, G., 1998. *Red squirrel conservation – practice note*. Edinburgh: Forestry Commission.

KEY CARD:

Badger

(*Meles meles*)

Description

The badger is a nocturnal mammal generally associated with woodland and grassland habitats, and is specifically adapted for a life underground. Their distinctive black and white head markings make them easy to identify. Body fur tends to be grey in colour but black and ginger colour variations also occur. They grow up to 750mm (head to tail) and weigh an average of 10 to 12Kg (males being slightly larger than females).

Badger
(*Meles meles*)
Photo: Laurie Campbell

Life-Cycle and Behaviour

Badgers live in social groups, sometimes called clans, which can vary substantially in size. Together the group defend a territory in the order of 50 Ha in size from adjacent badger social groups. Badgers live in underground tunnel systems known as setts, which are used by successive generations. Badgers give birth to 1-4 young between January and March, and cubs do not emerge from the sett until April. They are less active over winter when they can stay below ground for prolonged periods. Badgers are omnivorous, feeding on earthworms, other invertebrates, fruits and roots, as well as on carrion and crops.

Habitat Preferences

Badgers occur within a wide variety of habitat types in both lowland and upland regions. Setts are often located within woodland and woodland edge, hedgerow and scrub habitats, especially where these occur adjacent to good foraging habitat such as grazed grasslands. Over half of badger setts in Ireland are found along hedgerows.

Survey Techniques

Given the national distribution of badgers across a wide range of habitat types, it is likely that they will be encountered on most road schemes. This can be confirmed through simple field sign surveys, including searches for latrines, badger paths and setts.

Where badgers are confirmed to be present, it will be necessary to establish the locations and status of setts that would be affected by the proposed road and the locations where badgers may

encounter the scheme. In order to determine the location at which badgers would encounter a new road, or at which they already encounter an existing road, surveys should be targeted towards identifying badger paths. For an existing road, data can also be obtained from desk study records of badger road casualties. This information is used to guide the design and layout of appropriate safe crossings for badgers and associated fencing.

Surveys for badger setts should extend out from the scheme corridor, with the appropriate survey distance being determined by the nature of the works. Setts should be mapped and classified according to their status (main, subsidiary, annex, outlier), and level of usage (disused, partially-used, well-used). 'Main' setts are usually large, well-established and generally in continuous use, and are where the cubs are most frequently born and reared. Other setts types are classified by the number of entrances and by their proximity and connectivity to the main sett. All of the above survey elements should be undertaken as part of the multi-disciplinary walkover survey. Follow-up investigations should only be required in locations where dense vegetation has precluded an exhaustive search for setts during the initial survey.

Bait-marking investigations rely on the technique of feeding coloured plastic pellets at putative badger main setts to delineate territorial boundaries or to identify the status and 'ownership' of setts. It will rarely be necessary to delineate territorial boundaries for a road project, but in those situations where setts cannot be avoided, restricted bait-marking exercises may be needed to confirm sett status and ownership, and suitable locations for artificial setts.

The appropriate techniques for undertaking pre-construction badger surveys are described in the NRA publication '*Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes*'.

Optimum Survey Period

Surveys to identify setts and field signs can be undertaken at any time of the year, but are most effective between November and April when vegetation cover is reduced. However, until mid-January, badgers are less active during colder weather and setts can appear less well-used.

The timing of bait-marking investigations is more critical. Comprehensive investigations to delineate territorial boundaries (if required) need to be undertaken during the spring (mid-February to end-April). The period early-September to mid-October can sometimes yield useful additional information, but the more limited application of the technique (e.g. to identify the status and 'ownership' of setts) can usually be carried out spring to autumn inclusive.

Mitigation, compensation and enhancement

Details of appropriate mitigation for badgers in relation to road schemes are provided in the NRA publication '*Guidelines for the treatment of badgers prior to the construction of national road schemes*'

Key reference

- Smal, C., 1995. *The badger and habitat survey of Ireland*. Dublin: The Stationery Office.
- National Roads Authority, 2006. *Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes*. Dublin: National Roads Authority.
- Harris, S., Cresswell, P. & Jefferies, D.J., 1989. *Surveying Badgers*. London: Mammal Society.
- Neal, E.G. & Cheeseman, C., 2002. *Badgers*. 2nd Ed. London: Christopher Helm.National Roads Authority, 2006. *Guidelines for the Treatment of Badgers prior to the Construction of National Road Schemes*. Dublin: National Roads Authority.

KEY CARD:

Otter

(*Lutra lutra*)

Otter
(*Lutra lutra*)
Photo: Laurie Campbell

Description

The otter has brown fur with a pale face and belly. It is ideally adapted for swimming, with an elongated body, flattened head and thick, tapering tail, together measuring up to 1.5m in length.

Life-Cycle and Behaviour

The otter is primarily nocturnal. In freshwater habitats, otters feed on fish, amphibians (mainly frogs) and sometimes crayfish. Along coastal shorelines otters will feed on any available fish and crustaceans. Females give birth to two or three otter cubs, which stay within the security of the holt for two months. Cubs can be born at any time of year, although there is a peak in births between May and August. Females give birth in natal dens that are secluded and up to 1km away from main watercourses.

Habitat Preferences

Otters are found in both fresh- and salt-water. They are commonly found along rivers and around lakes. In the west they can be found along undisturbed rocky shores and inshore islands. Otters are also found away from watercourses, and will use drains and ditches, as well as other (non-aquatic) linear features to move between catchments.

Survey Techniques

Where watercourses or other wetland features are present within a route corridor and impacts on them are likely, it may be necessary to undertake detailed otter surveys. A variety of survey techniques may be appropriate, dependent upon the likely impacts, as described below.

Given the national distribution of otters, it is likely that they will be present on any watercourse that might be encountered. This can be confirmed through simple field sign surveys including searches for spraints (otter droppings), footprints or slides. Wherever possible, the presence of otters should be confirmed as part of the multi-disciplinary walkover survey.

In order to determine the location at which otters would encounter a new road, or at which they already encounter an existing road, surveys should be targeted towards identifying otter paths, particularly where these may be located away from watercourses. Crossing points on existing

roads can be identified from searches for field signs under bridges or culverts, or desk study records of otter road casualties. This information should be used to guide the design and layout of appropriate safe crossings for otters and associated fencing.

Where otters are present it will be particularly important to determine whether or not any resting sites (such as holts or couches) are present, and their level of importance. Holts tend to be tunnelled holes in riverbanks or cavities in tree roots or under rock piles. Holts are used in the day time as a resting place but also for giving birth to cubs (natal holts) or rearing cubs. The female may also construct couches (above ground resting sites) where there is no alternative site for breeding. Couches are generally mats of nesting material that can be located in vegetation on riverbanks or away from water in secluded areas. Attempts should be made to record holts or areas that might contain them, during the multi-disciplinary walkover survey. Repeat inspections of particular features may then be necessary, e.g. to make a careful search from within watercourse channels or to search dense vegetation. Some monitoring may also be required to determine the importance of particular structures or parts of a watercourse.

Initially, surveys will be required to identify structures which could potentially be used as resting sites, followed by targeted inspections of any such features for evidence of use by otters. Given that otters can use such features on a relatively infrequent basis, this is likely to require multiple visits over the course of an extended period (up to 12 months). The importance of a structure as a natal or rearing holt can only be reliably determined by either the use of remote cameras or watching the structure from an appropriate distance. Where the use of a feature by otters is identified, disturbance through monitoring should be minimised. Surveys for resting sites should extend along watercourses for an appropriate distance. The appropriate survey distance would be determined by the nature of the works and the distance at which otters would be likely to experience disturbance; this should be determined as part of the assessment of the project's 'zone of influence' (see Section).

The appropriate techniques for undertaking pre-construction otter surveys are described in the NRA publication *Guidelines for the Treatment of otters prior to the Construction of National Road Schemes*.

Optimum Survey Period

Otter surveys can be undertaken at any time of year, but are less likely to provide reliable results during mid- to late-summer, when the presence of dense vegetation may make it difficult to find field signs and holts. Surveys may also be unreliable if undertaken during or immediately following periods of high flow or after heavy rain, since many field signs may have been washed away.

Mitigation, compensation and enhancement

Details of appropriate mitigation for otters in relation to road schemes are provided in the NRA publication *Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes*.

Key reference

- Bailey, M. and Rochford J., 2006. *Otter Survey of Ireland 2004/2005. Irish Wildlife Manuals, No. 23*. Dublin: National Parks and Wildlife Service, Department of Environment, Heritage and Local Government.
- Chanin, P., 2003. *Monitoring the otter* Lutra lutra. *Conserving Natura 2000 Rivers Monitoring. Series No. 10*. Peterborough: English Nature.
- National Roads Authority. *Guidelines for the Treatment of Otters prior to the Construction of National Road Schemes*. Dublin: National Roads Authority.
- NPWS, 2008. *Species Action Plan, Otter* Lutra lutra. Dublin: NPWS.

KEY CARD:

Pine Marten

(*Martes martes*)

Pine Marten
(*Martes martes*)
Photo: Laurie Campbell

Description

Pine martens have brown fur with a cream to yellow throat patch extending from chin to chest, and pale inner ears. The winter coat is longer, thicker and lighter in colour than the summer coat, and the tail is bushier. They are the size of a small domestic cat, with males about one third larger than females.

Life-Cycle and Behaviour

Pine martens are almost exclusively nocturnal during winter. They are commonly active during the day as well as during the night in summer. By comparison with similar Irish species, pine martens are highly agile tree climbers. They use their tail to aid balance and often leap between branches. They have been recorded travelling typical distances of some 5-8km per night. Pine martens are solitary foragers. They hold intra-sexual territories, whereby adults of the same sex are excluded, but territories of males and females may overlap, with one or two female territories commonly occurring in one male's territory. Home range sizes of pine martens can vary greatly, depending on the quality of the habitat available to them. In habitat with abundant food sources in Ireland, they have been recorded at between 0.42-0.80km^2 for males and 0.14-0.25km^2 for females. They largely forage on the ground, opportunistically taking a wide variety of food including small mammals, birds, carrion, invertebrates, fruit, nuts and amphibians. Two or three food categories usually dominate the diet, depending on availability in a given season. Fruit has been found to be a more important food source in Ireland than elsewhere in Europe, with small mammals and birds also important. Mating takes place in July and August. Pregnancy is delayed for approximately 6 months, with young born between late-March and early-April. Pine martens tend to make use of existing cavities for dens, such as tree-holes, rock-crevices or existing squirrel dreys. These will be lined with dried grass. Dens above ground are preferred, out of the reach of predators such as foxes. A wide variety of den types are used, depending on local availability. Barns, outhouses and attics are sometimes used, as are boxes erected in trees.

Habitat Preferences

Pine martens have historically been associated with woodland areas, and in Europe they are most frequently found in coniferous and broadleaved woodland and scrub. In Ireland deforestation has meant that a wider variety of habitats are used by pine martens. They have adapted to pasture, moors and coastal areas, surviving in hazel scrub and limestone pavement habitat in the Burren

in County Clare, and sea cliffs in the north of Ireland. They are most likely to be found in more enclosed, heavily-wooded areas than predominantly open habitats. However, habitats with abundant den sites, secure from predators, and plentiful foraging resources items are as important as vegetation cover.

Survey Techniques

It may be that there will be existing records of pine martens in the vicinity of the scheme in question, or that reliable signs of their presence can be found during earlier surveys. If, following the desk study and multi-disciplinary walkover survey, the status of pine martens in the vicinity of the scheme remains equivocal, further targeted surveys may be necessary to confirm the presence of the species, and/or to collect information to inform a comprehensive impact assessment. However, direct observations are rare and the reliable identification of scats (droppings) can be difficult. In most cases, where the scheme is within or close to their geographic range and habitat is considered suitable, the presence of pine martens can be assumed, on a precautionary basis, without the need for targeted surveys.

Where it *is* considered necessary to confirm the presence or absence of pine martens, surveys should consist of walking transects and searching for characteristic scats, supplemented by direct observations wherever possible. Prominent features where pine martens may be likely to deposit scats (such as tree stumps, dead logs or stones) close to transects should also be searched. Transect size and numbers will vary depending on the area surveyed, as a guide 4 x 1.5km transects per $10km^2$ stratified across suitable habitat should be used. Transects should consist of little-used forest trails or paths, animal trails or paved minor roads adjacent to suitable habitat. Scats should be collected and placed in sealed containers/bags, and can be sent for DNA analysis to confirm species identification. Scats vary greatly in colour, shape and size, depending on diet, and can be difficult to differentiate from foxes, mink and stoats. They have a sweet, musky scent, but this is not always conclusive; DNA analysis is the only reliable diagnostic technique for identifying scats.

Incidental observations of pine martens should also be collected, but sightings are rare and this should not be relied upon as a survey method. Likewise, records of dead pine martens on roads may also be used to confirm presence in an area.

Although fur snagging (hair tube) surveys have successfully been used both to confirm the presence of pine martens and to conduct population density surveys, they are rarely appropriate for EIAs of road projects. If they are to be used, the technique is as follows: The tubes, made either from standard PVC sewer pipes contain adhesive or wood tunnels with a metal spring, yield hairs which can be identified by microscopic examination or by DNA analysis. They are baited with food and positioned approximately 1.5m high in trees. These are situated on transects and checked and re-baited daily for six days.

In those situations where the presence of pine martens is considered likely, it will then be important to focus survey effort on potential den sites, since the avoidance of these will be the key element of any mitigation measures. It should be possible to incorporate searches of potential den sites as part of the multi-disciplinary walkover survey, with follow-up searches of complex

features or investigations of the use of particular structures, as appropriate.

Optimum Survey Period

It is possible to undertake scat count and fur snagging surveys at any time of year. Direct observation surveys produce the most reliable results when undertaken during the periods when pine martens are most active. Therefore, surveys should be carried out during the day during the summer months, including the early morning period, and are unlikely to be successful in winter. Scat surveys in deciduous woodland are likely to be most effective during winter or early spring, because the scats tend to be easier to find at this time of year.

Mitigation, compensation and enhancement

Following population declines due to habitat loss and persecution, the range of pine martens in Ireland is now increasing. Although vehicle collisions are now likely to be one of the major threats to the survival of individuals, habitat fragmentation, along with the scarcity of suitable woodland, are the main factors preventing the expansion of pine martens into their former range. Steps should be taken to minimise the effects of road projects through the retention of strategically important habitat links wherever possible.

Small-scale alterations in alignment or land-take should also be considered to avoid impacts on known (and, where possible, potential) den sites.

Where avoiding impacts on valuable habitat features for pine martens is not possible, mitigation should focus on the planting or enhancement of woodland habitat, incorporating a diverse range of woodland species, with the aim of maximising fruit production and prey availability. The retention of old trees with cavities suitable for use as dens should be considered, as should the provision of artificial dens (nest boxes), although it would be inappropriate to site these in close proximity to roads.

It is not feasible to install fences to prevent pine martens from crossing roads or diverting them to safe crossing structures, as would be the case for otters or badgers. Similarly, there is little evidence of the effectiveness of roadside reflectors in reducing the numbers of martens killed by traffic. It is likely that 'landscape-scale' links over or under roads, such as clear-span bridges or viaduct structures will become adopted by pine martens as preferential routes and thus may reduce road-related mortality in the vicinity of the structure in question.

Key reference

- Balharry, E., Jefferies, D.J. and Birks, J.D.S, 2008. Pine Marten (*Martes martes*). In Harris, S. and Yalden, D.W., eds. *Mammals of the British Isles*. London:The Mammal Society, 2008.
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- Lynch, A.B., Brown, M.J.F. & Rochford J.M., 2006. Fur snagging as a method of evaluating the presence and abundance of a small carnivore, the pine marten (*Martes martes*). *Journal of Zoology*, Vol. 270, p. 330-339.
- Lynch, A.B. and McCann, Y., 2007. The diet of the pine marten (*Martes martes*) in Killarney National Park. *Biology and Environment: Proceedings of the Royal Irish Academy,* Vol. 107B, p. 67-76.
- Messenger, J.E. and Birks, J.D.S., 2004. *Guidance note on the VWT fur snagging device for pine martens*. Ledbury: The Vincent Wildlife Trust. Available at:
- O'Mahoney, D., O'Reailly, C. and Turner, P., 2006. *National Pine Marten Survey of Ireland 2005*. Dublin: Coford Connects.

KEY CARD:

Deer

Description

There are three species of deer occurring as well-established populations in Ireland: fallow deer (*Dama dama*), red deer (*Cervus elaphus*) and sika deer (*Cervus nippon*), with some more recent Records of Reeves' muntjac (*Muntiacus reevesi*).

Fallow deer
(*Dama dama*)
Photo: Laurie Campbell

The red deer is Ireland's only native species of deer and is also the largest, with stags measuring up to 135cm at shoulder height. In summer, the red deer is red-brown in colour with a grey underside, whilst during the winter, the coat is grey-brown in colour. It has a short tail and pale rump.

Fallow deer are smaller than red deer with bucks measuring approximately 90cm at shoulder height. Coat colour varies considerably from black, white or brown to yellow-brown. The most common colour is chestnut-brown with white spots on the back and flanks, and a black line along the middle of the back. The rump is white and is surrounded with a black border. The tail is white with a black stripe down the middle.

Sika deer is the smallest deer species found in Ireland; stags measure up to 80cm at shoulder height. They are superficially similar in appearance to red deer, although smaller. They are brown in colour (turning grey-brown to black in winter), gradually becoming lighter from the back to the underside, with pale spots on the flanks. The rump is white and heart-shaped, and is exposed when alarmed.

Life-Cycle and Behaviour

All deer species are herbivores. They feed on a variety of plants, fruits, shrubs, trees and crops according to local food availability. They are active during both day and night, but peak activity occurs at dawn and dusk.

For red deer, breeding occurs between September and late-October/November, with a single calf born between May and June. For fallow deer, breeding occurs during October and November, with fawns born in June. Sika deer breed between September and October, with calves born in early-June. Cross-breeding occurs between red and sika deer giving a slightly larger animal.

Habitat Preferences

Red deer have limited distribution and are found in woodland habitat as well as upland moorland and mountainous areas. Fallow deer are widespread and are found in all woodland habitats, both upland and lowland. Sika deer colonise all types of woodland, but are often found in woodlands on acid soils and within pine plantations.

Survey Techniques

If the presence of deer has been confirmed by desk study records, or where the multi-disciplinary walkover survey has identified field signs (including pellets, slots (footprints) and sightings), it is appropriate to consider the significance of any impacts associated with the road project. Further surveys may be necessary in order to inform this assessment. However, as mitigation measures for deer in relation to road projects are relatively straightforward, in many cases targeted surveys are unlikely to be required.

Targeted surveys for red deer are only appropriate where the status of a deer population and the importance of different areas of habitat are unclear, or where the implementation of mitigation measures would be problematic. The additional information collected during targeted surveys is necessary in these circumstances to inform the assessment of potential impacts of a road scheme and to help inform mitigation design. Such surveys involve a combination of direct and indirect observations.

Direct observation techniques include: (i) undertaking a deer count from vantage points; (ii) driving or walking transects; and (iii) nocturnal 'lamping' surveys. Although surveys conducted during the daytime may not be reliable where deer are present at low population densities, it may not be practicable to undertake exhaustive nocturnal surveys in some areas due to health and safety constraints. As an indirect observation method, deer pellets are counted to provide a reliable confirmation of presence/absence of deer, even at low densities. It should be noted that neither direct nor indirect observation techniques provide reliable information relating to deer population densities as assumptions have to be made about rates of defecation and decomposition.

Optimum Survey Period

Whilst direct observation methods can be carried out at any time of year, the highest levels of accuracy are likely to be achieved if surveys are undertaken during the optimum period. This is during the breeding season in autumn, when vegetation cover is low and when deer are most active. Pellet counts can also be undertaken at any time of year but are best undertaken before vegetation cover increases significantly in the spring.

Mitigation, compensation and enhancement

Deer-resistant fencing installed between the carriageway and adjacent habitat is used to prevent deer from entering the carriageway, thus minimising the risk of deer mortality as a result of deer-vehicle collisions. Fencing must be installed to an appropriate specification to be effective. In addition, roadside vegetation can be managed in order to discourage deer from foraging in habitat

within close proximity to the carriageway. Visual deterrents can also be used to discourage deer from crossing the road in the presence of traffic. These include installation of roadside reflectors, mirrors and foils. However, there is currently little evidence to support the effectiveness of such measures. Deer warning signs should be erected in order to alert motorists of the presence of deer.

Key reference

- Daniels, M.J., 2006. Estimating red deer Cervus elaphus populations: an analysis of variation and cost-effectiveness of counting methods. *Mammal Review*, 36, p. 235-247.
- Marques, F.F.C. et al, 2001. Estimating deer abundance from line transect surveys of dung: sika deer in southern Scotland. *Journal of Applied Ecology*, 38, p. 349-363.

APPENDICES

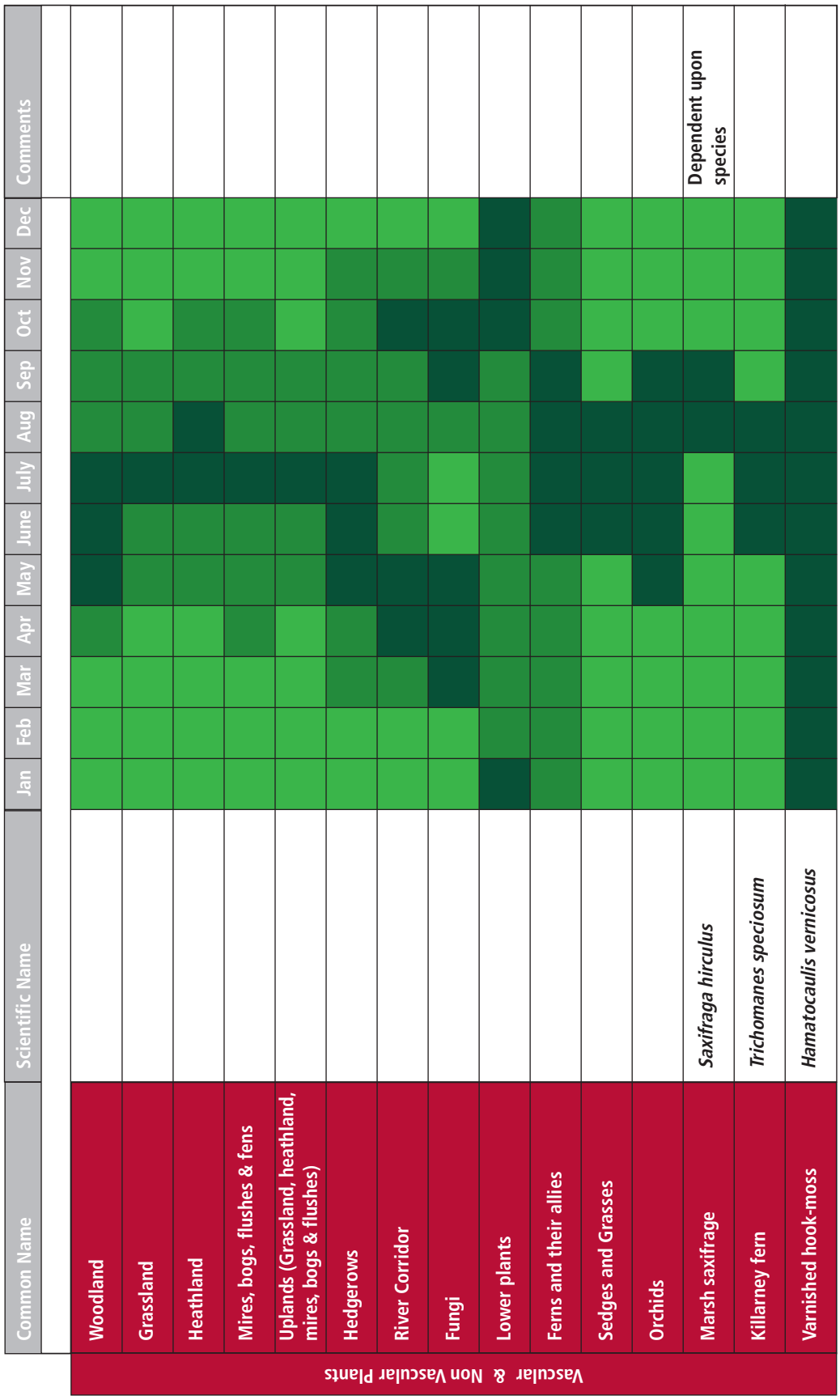
APPENDIX I – DESK STUDY CONTACTS AND KEY CONSULTEES

Organisations	Type of ecological records available	Website
Statutory Bodies		
National Parks and Wildlife Service	Statutory designated sites, location boundaries. The NPWS is charged with the conservation of a range of habitats and species in Ireland. The maps and data viewer available free on the website provides information on Natural Heritage Areas, Special Areas of Conservation, Special Protection Areas, Nature Reserves, National Parks and indicative location details for protected species on a 10km2 grid square basis.	www.npws.ie/en www.designatednatureareas.ie
Environmental Protection Agency Ireland	The Environmental Protection Agency (EPA) has responsibilities for a wide range of licensing, enforcement, monitoring and assessment activities associated with environmental protection. The EPA also hold environmental quality data and environmental monitoring programmes and provide technical guidance on a range of issues	www.epa.ie
The Heritage Council	Proposes policies and priorities for the identification, protection, preservation and enhancement of Irelands National Heritage including monuments, archaeological objects, heritage objects such as art and industrial works, documents and genealogical records, architectural heritage, flora, fauna, wildlife habitats, landscapes, seascapes, wrecks, geology, heritage gardens, parks and inland waterways	www.heritagecouncil.ie
Local Organisations		
Department of the Environment, Heritage and Local Government	Pursues objectives of sustainable development aiming to achieve a high quality environment with effective environmental protection and to achieve effective conservation of our natural heritage and built environment. Links to county councils and local area plans.	www.environ.ie/en
Biological Record centres	Protected species, LBAP species, HBAPs, non-statutory wildlife sites, protected species, RTA's	Contact Local Council

Organisations	Type of ecological records available	Website
The Irish Wildlife Trusts	Protected species, non-statutory wildlife sites	http://www.iwt.ie
National Groups		
An Taisce (the National Trust for Ireland)	Reserve boundaries, species lists (location specific)	http://www.antaisce.org
Biology.ie	Collates data on the distribution and abundance of species across Ireland including: National Lizard Survey, National Bird Survey, National Road Kill Survey & the National Butterfly survey	www.biology.ie
Badger Watch Ireland	Badger Distribution throughout Ireland	www.badgerwatch.ie
Bat Conservation Ireland	Bat distribution records	www.batconservationireland.org
Bird Watch Ireland	National Bird Monitoring Programme	www.birdwatchireland.ie
Butterfly Ireland	Butterfly distribution records	http://www.butterflyireland.com
Bees of Ireland	Bee distribution records	http://www.tcd.ie/Zoology/research/Bees/index.php
Central Fisheries Board	Management and Monitoring of Fisheries within Ireland	www.cfb.ie
HabitatsOnline	Range of information on the distribution of habitats and species throughout Ireland and Northern Ireland	www.habitasonline.org.uk
Irish Deer Society	Deer distribution and management information	www.irishdeersociety.ie
Irish Mammal Survey	Distribution maps for Mammals throughout Ireland	http://www.ucd.ie/bioenvsci/mammal
Irish National Biodiversity Research Platform	Biodiversity Action Plans	www.biodiversityresearch.ie

Organisations	Type of ecological records available	Website
National Biodiversity Data Centre	Data on the distribution and status of species and habitats throughout Ireland	www.nbdc.ie
BSBI recorders	Irish plants	www.bsbi.org.uk
Woodlands of Ireland	Information on native woodlands within Ireland	www.woodlandsofireland.com
Independent local interest groups	Species specific groups (varies between counties)	N/A
Museums		N/A
Universities		N/A
Existing Information		
Previous (desk studies) for projects in the area.	Relevant ecological records	N/A
Previous scoping report or consultation meeting.	Relevant ecological records	N/A

APPENDIX II – OPTIMUM SEASONAL SURVEY TIMINGS



	Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Comments
Terrestrial Invertebrates	Terrestrial Invertebrates (general)														
	Kerry slug	*Geomalacus maculosus*													
	Narrow-mouthed whorl snail	*Vertigo angustior*													
	Geyer's whorl snail	*Vertigo geyeri*													
	Desmoulin's whorl snail	*Vertigo moulinsiana*													
	Marsh fritillary	*Euphydryas aurinia*			**	**		*	*	**	**				Spring surveys are less reliable and can be used to confirm presence but not absence
Aquatic Invertebrates	Aquatic Invertebrates (general)				+	+	+	+	+	+	+	+	+		
	White-clawed crayfish	*Austropotamobius pallipes*													
	Freshwater pearl mussel	*Margaritifera margaritifera*													
Fish	Fish (general)														
	River lamprey	*Lampetra fluviatilis*													Survey periods for migrating/spawning adults. Ammocoete surveys undertaken August to October for all three species.
	Brook lamprey	*Lampetra planeri*													
	Sea lamprey	*Petromyzon marinus*													
	Sturgeon	*Acipenser sturio*													
	Atlantic salmon	*Salmo salar*													Spawning periods should be avoided

	Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Comments
Fish	Allis shad	*Alosa alosa*													
	Twaite shad	*Alosa fallax fallax*													
	Killarney shad	*Alosa fallax killarnensis*													
	Pollan	*Coregonus autumnalis pollan*													
Amphibians	Natterjack toad	*Bufo (Epidalea) calamita*													
	Common frog	*Rana temporaria*													
	Smooth newt	*Triturus (Lissotriton) vulgaris*													
Rep-tiles	Viviparous lizard	*Lacerta (Zootoca) vivipara*													
Birds	Breeding birds (general)														
	Over-wintering birds (general)														
	Geese and Swans														
	Hen harrier	*Circus cyaneus*													
	Corncrake	*Crex crex*													Corncrakes may be present in Ireland from April to September, but are very unlikely to be seen/heard outside these periods.
	Barn owl	*Tyto alba*													Potential nest sites should ideally be identified during the winter months; however, surveys to confirm breeding should be undertaken in June & July under licence
	Kingfisher	*Alcedo atthis*													Breeding surveys should only be conducted from March to July, but presence/absence surveys may be carried out at any time of year.

	Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec	Comments
Mammals	Otter	*Lutra lutra*													Bait marking studies should be undertaken between February and April or October/September
	Badger	*Meles meles*													
	Deer (all species)														
	Irish hare	*Lepus timidus hibernicus*													
	Hedgehog	*Erinaceus europaeus*													
	Red squirrel	*Sciurus vulgaris*													
	Pine marten	*Martes martes*													
	Irish stoat	*Mustela erminea hibernica*													
	Pygmy shrew	*Sorex minutus*													
	Bats (all species)		See NRA guidelines 'Guidelines for the Treatment of Bats During the Construction of National Road Schemes'												

Optimal survey period

Sub-optimal survey period

Surveys not appropriate

* Survey for adults

** Survey for larvae

\+ At least two sampling periods during these seasons, one in spring and one in autumn, with a further summer sample for some waterbodies

APPENDIX III

Legal, policy and conservation status

The species discussed within this document are subject to protection under several different instruments of Irish Law and European Policy. The following table outlines the legal, policy and conservation status of each of the species included Chapter 4.

Policy and legal status

The primary legislation that protects biodiversity and nature conservation in Ireland is the Wildlife Act, 1976, and its associated regulations and amendments. These include, inter alia, the following:

- Wildlife Act, 1976 (Protection of Wild Animals) Regulations, 1980;
- Wildlife Act, 1976 (Protection of Wild Animals) Regulations, 1990;
- Flora (Protection) Order, 1999;
- Wildlife (Amendment) Act, 2000.
- The main European policy relating to nature conservation is as follows:
- EU Birds Directive (Council Directive 79/409/EEC);
- EU Habitats Directive (Council Directive 92/43/EEC);

The EU Habitats Directive was transposed into Irish law under the European Communities (Natural Habitats) Regulations, 1997. The European Communities (Conservation of Wild Birds) Regulations, 1985, provide for the designation of Special Protection Areas (SPAs) for these species.

Although the 1976 Act provided very good protection for species, it was comparatively weak in protecting habitats. The Wildlife (Amendment) Act, 2000 and the European Union (Natural Habitats) Regulations 1997-2005 substantially increased overall protection for biodiversity, including habitats, in Ireland.

Conservation status

Birds

Birdwatch Ireland, in association with RSPB Northern Ireland, has compiled a list of bird species that require conservation measures on the island of Ireland. The conservation status of each species is listed as red (high conservation concern), amber (medium conservation concern) or green (not threatened). This conservation status is not related to the legal status of the species.

Other habitats and species

The National Parks and Wildlife Service has issued a publication entitled Conservation Status in Ireland of Habitats and Species listed in the European Council Directive on the Conservation of Habitats, Flora and Fauna 92/43/EEC (NPWS, 2008). This publication describes the status of each of the habitats and species listed in the EU Habitats Directive under the following headings: bad, poor, good or unknown.

Group	Latin name	Common name	Birds of Conservation Concern in Ireland*	Conservation status (overall)**	Legal Status								
					Habitats Directive			Birds Directive	Section 21 of the Wildlife Act, 1976	Section 23 of the Wildlife Act, 1976			Section 22 of the Wildlife Act, 1976
					Annex II[#]	Annex IV[##]	Annex V[###]	Annex I[†]	Flora Protection Order, 1999[‡]	Schedule V of the Wildlife Act, 1976[‡‡]	Wildlife Act 1976 (Protection of Wild Animals) Regulations, 1980 (S.I. 282 of 1980)[±]	Wildlife Act 1976 (Protection of Wild Animals) Regulations, 1990 (S.I. No. 112 of 1990)[±±]	European Communities (Wildlife Act 1976) (Amendment) Regulations, 1985 (S.I. No. 397 of 1985) (Removed all birds from the Third Schedule)[††]
Habitats, plants and fungi	*Hamatocaulis vernicosus*	Varnished hook-moss	N/A	Good	Yes	No	No	N/A	Yes	N/A	N/A	N/A	N/A
	Trichomanes speciosum	Killarney fern	N/A	Good	Yes	Yes	No	N/A	Yes	N/A	N/A	N/A	N/A
	Eriophorum gracile	Slender cotton grass	N/A	N/A	No	No	No	N/A	Yes	N/A	N/A	N/A	N/A
	Hordeum secalinum	Meadow barley	N/A	N/A	No	No	No	N/A	Yes	N/A	N/A	N/A	N/A
	Saxifraga hirculus	(Yellow) marsh saxifage	N/A	Good	Yes	Yes	No	N/A	Yes	N/A	N/A	N/A	N/A
	Spiranthes romanzoffiana	Irish lady's tresses	N/A	N/A	No	No	No	N/A	Yes	N/A	N/A	N/A	N/A
	Cephalanthera longifolia	Narrow-leaved helleborine	N/A	N/A	No	No	No	N/A	Yes	N/A	N/A	N/A	N/A
Terrestrial invertebrates	*Vertigo angustior*	Narrow-mouthed whorl snail	N/A	Poor	Yes	No	No	N/A	N/A	No	No	No	N/A
	Vertigo moulinsiana	Desmoulin's whorl snail	N/A	Bad	Yes	No	No	N/A	N/A	No	No	No	N/A
	Vertigo geyeri	Geyer's whorl snail	N/A	Poor	Yes	No	No	N/A	N/A	No	No	No	N/A
	Geomalacus maculosus	Kerry slug	N/A	Good	Yes	Yes	No	N/A	N/A	No	No	Yes	N/A
	Euphydryas aurinia	Marsh fritillary	N/A	Poor	Yes	No	No	N/A	N/A	No	No	No	N/A
	Margaritifera margaritifera	Freshwater pearl mussel	N/A	Bad	Yes	No	Yes	N/A	N/A	No	No	Yes	N/A
	Austropotamobius pallipes	White-clawed crayfish	N/A	Poor	Yes	No	Yes	N/A	N/A	No	No	Yes	N/A
Fish	*Lampetra fluviatilis*	River lamprey	N/A	Good	Yes	No	Yes	N/A	N/A	No	No	No	N/A
	Lampetra planeri	Brook lamprey	N/A	Good	Yes	No	No	N/A	N/A	No	No	No	N/A
	Salmo salar	Atlantic salmon	N/A	Bad	Yes	No	Yes	N/A	N/A	No	No	No	N/A
	Alosa alosa	Allis shad	N/A	Unknown	Yes	No	Yes	N/A	N/A	No	No	No	N/A
	Alosa fallax killarnensis	Killarney shad	N/A	Good	Yes	No	Yes	N/A	N/A	No	No	No	N/A
	Alosa fallax fallax	Twaite shad	N/A	Bad	Yes	No	Yes	N/A	N/A	No	No	No	N/A
Amphibians	*Bufo (Epidalea) calamita*	Natterjack toad	N/A	Bad	No	Yes	No	N/A	N/A	Yes	No	No	N/A
	Triturus (Lissotriton) vulgaris	Common (smooth) newt	N/A	N/A	No	No	No	N/A	N/A	No	Yes	No	N/A
	Rana temporaria	Common frog	N/A	Poor	No	No	Yes	N/A	N/A	No	Yes	No	N/A

Group	Latin name	Common name	Birds of Conservation Concern in Ireland*	Conservation status (overall)**	Legal Status								
					Habitats Directive			Birds Directive	Section 21 of the Wildlife Act, 1976	Section 23 of the Wildlife Act, 1976			Section 22 of the Wildlife Act, 1976
					Annex II#	Annex IV##	Annex V###	Annex I†	Flora Protection Order, 1999‡	Schedule V of the Wildlife Act, 1976‡‡	Wildlife Act 1976 (Protection of Wild Animals) Regulations, 1980 (S.I. 282 of 1980)±	Wildlife Act 1976 (Protection of Wild Animals) Regulations, 1990 (S.I. No. 112 of 1990)±±	European Communities (Wildlife Act 1976) (Amendment) Regulations, 1985 (S.I. No. 397 of 1985) (Removed all birds from the Third Schedule)††
Rep-tiles	*Lacerta (Zootoca) vivipara*	Common (viviparous) lizard	N/A	N/A	No	No	No	N/A	N/A	No	Yes	No	N/A
Birds††	*Anser albifrons flavirostris*	Greenland white-fronted goose	Amber List	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	Yes
	Anser anser	Greylag goose	Amber List	N/A	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A	Yes
	Branta leucopsis	Barnacle goose	Amber List	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	Yes
	Cygnus cygnus	Whooper swan	Amber List	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	Yes
	Cygnus bewickii (Cygnus columbianus bewickii)	Bewick's swan	Amber List	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	Yes
	Tyto alba	Barn owl	Red List	N/A	N/A	N/A	N/A	No	N/A	N/A	N/A	N/A	Yes
	Circus cyaneus	Hen harrier	Red List	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	Yes
	Crex crex	Corncrake	Red List	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	Yes
	Alcedo atthis	European kingfisher	Amber List	N/A	N/A	N/A	N/A	Yes	N/A	N/A	N/A	N/A	Yes
Mammals	*Sciurus vulgaris*	Red squirrel	N/A	N/A	No	No	No	N/A	N/A	Yes	No	No	N/A
	Lutra lutra	European otter	N/A	Poor	Yes	Yes	No	N/A	N/A	Yes	No	No	N/A
	Meles meles	Badger	N/A	N/A	No	No	No	N/A	N/A	Yes	No	No	N/A
	Dama dama	Fallow deer	N/A	N/A	No	No	No	N/A	N/A	Yes	No	No	N/A
	Cervus elaphus	Red deer	N/A	N/A	No	No	No	N/A	N/A	Yes	No	No	N/A
	Lepus timidus hibernicus	Irish hare	N/A	Poor	No	No	Yes	N/A	N/A	Yes	No	No	N/A
	Cervus nippon	Sika deer	N/A	N/A	No	No	No	N/A	N/A	Yes	No	No	N/A
	Martes martes	Pine marten	N/A	Good	No	No	Yes	N/A	N/A	Yes	No	No	N/A

* BirdWatch Ireland and the RSPB NI have agreed a list of priority bird species for conservation action on the island of Ireland. The Red List birds are of high conservation concern, the Amber List birds are of medium conservation concern and the Green List birds are not considered threatened. The conservation status is not related to the legal status for these species.

** The National Parks and Wildlife Service has issued a publication entitled *Conservation Status in Ireland of Habitats and Species listed in the European Council Directive on the Conservation of Habitats, Flora and Fauna 92/43/EEC* (NPWS, 2008). This publication describes the status of each of the habitats and species present in Ireland and listed in the EU Habitats Directive under the following headings: bad, poor, good or unknown.

\# Species listed on Annex II of the EU Habitats Directive (Council Directive 92/43/EEC) are those for which Special Areas of Conservation (SACs) can be designated. Restrictions on survey techniques which could result in significant disturbance to these species would apply when surveying in SACs or cSACs designated for them, or where they are identified as a 'qualifying interest' as a result of the protection conferred on them in these situations under the European Communities (Natural Habitats) Regulations, 1997. Any surveys that might require handling of or other interference with individual animals or disturbance to their habitat may need to be carried out by suitably qualified personnel in possession of an appropriate licence. Mitigation measures may also require a licence and should be developed in conjunction with NPWS and other relevant consultees.

\## Species listed on Annex IV are those species of community interest in need of strict protection. This means that any injury, deliberate capture, killing, or disturbance (particularly during breeding, rearing, hibernation and migration) of these species is an offence, as is the deliberate taking or destruction of eggs in the case of the natterjack toad. Damage to or destruction of breeding sites or resting places is also an offence, whether this is deliberate or not. Any surveys that might require handling of or other interference with individual animals or disturbance to their habitat may need to be carried out by suitably qualified personnel in possession of an appropriate licence. Mitigation measures may also require a licence and should be developed in conjunction with NPWS and other relevant consultees.

\### Species listed on Annex V of the EU Habitats Directive are those species of community interest whose taking in the wild and exploitation may be subject to management measures. They are also listed on Part II of the First Schedule of the European Communities (Natural Habitats) Regulations, 1997. The taking in the wild of these listed species is controlled under Section 21 of the Regulations.

† A number of bird species listed in Annex I of the Birds Directive (Council Directive 79/409/EEC) occur in Ireland. The European Communities (Conservation of Wild Birds) Regulations, 1985, provide for the designation of Special Protection Areas (SPAs) for these species, and within these sites prohibit any activities which would cause disturbance to the listed bird species and their habitats.

‡ It is an offence to cut, pick, collect, uproot or otherwise take, injure, damage, or destroy any specimen of the species listed under the Flora (Protection) Order, 1999. This includes the flowers, roots, seeds, spores or any other part of the plant. If, during walkover surveys, the presence of a protected species is suspected, removal of samples to confirm identification would therefore be an offence, unless carried out under licence. In practice, every effort should be made to confirm identification of protected plant species in situ, without damaging the plants, to avoid the need for a licence. Mitigation works (such as translocation or seed collection) would similarly be licensable and should be developed in consultation with the NPWS and other relevant consultees.

‡‡ It is an offence to injure these species or willfully interfere with or destroy its breeding or resting places. Although non-destructive surveys would not normally require a licence, any surveys that might require handling of or other interference with individual animals or disturbance to their habitat should be carried out only by suitably qualified personnel in possession of an appropriate licence. Mitigation measures may also require a licence and should be developed in conjunction with NPWS and other relevant consultees.

± The effect of these Regulations is to add these species to the list of protected species mentioned in Schedule V of the Wildlife Act, 1976. It is an offence to injure these species or willfully interfere with or destroy its breeding or resting places. Any surveys that might require handling of or other interference with individual animals or disturbance to their habitat should be carried out only by suitably qualified personnel in possession of an appropriate licence. Mitigation measures may also require a licence and should be developed in conjunction with NPWS and other relevant consultees.

±± The effect of these Regulations is to add these species to the list of protected species mentioned in Schedule V of the Wildlife Act, 1976. It is an offence to injure these species or willfully interfere with or destroy its breeding or resting places. Any surveys that might require handling of or other interference with individual animals or disturbance to their habitat should be carried out only by suitably qualified personnel in possession of an appropriate licence. Mitigation measures may also require a licence and should be developed in conjunction with NPWS and other relevant consultees.

†† Schedules 19 and 22 of the Wildlife Act, 1976, confer protection on wild birds, with the exception of those species listed on the Third Schedule of the Act. The 1985 Regulations amend these provisions of the Wildlife Act, 1976, for the purpose of giving full effect to the EU Birds Directive (Council Directive 79/409/EEC). The Regulations provide that certain species of wild birds hitherto included in the Third Schedule of the Wildlife Act, 1976, shall be removed from that Schedule. The effect of this provision is to declare these species to be protected species for the purposes of the Act. Wild birds are protected from unauthorised hunting, injury, and willful taking, removal, destruction, injury or mutilation of eggs and nests. Willful disturbance of birds on or near nests containing eggs or young is also an offence.

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