ECOLOGICAL IMPACT ASSESSMENT (EcIA)

Towards the development of EcIA Guidelines for Australia and New Zealand

ENVIRONMENT INSTITUTE OF AUSTRALIA AND NEW ZEALAND

ENVIRONMENT INSTITUTE OF AUSTRALIA AND NEW ZEALAND, ECOLOGY GROUP
CONSULTATION DRAFT June 2009

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Contents

This document has been divided into short sections, each describing fundamental parts of the EcIA process. In each section are bullet lists and tables summarising key processes.

Acknowledgments

This document is a synthesis of various publications, representing widely accepted international best practice (see references) about how to do EcIA and create biodiversity outcomes. **We are particularly grateful to the Institute of Ecology and Environmental Management** for allowing us to use substantial sections from their EcIA guidelines. This has made the process of creating these guidelines far easier than if it were to be done from scratch. The production of this document is as much, if not more, a testament to their expertise and hard work as it is to ours. We would also like to thank Professor Mark Burgman and Dr Chris McGrath for agreeing to read the document and provide a foreword, at short notice.

Forewords

Professor Mark Burgman, FAA

Adrienne Clarke Chair of Botany & Director, Australian Centre of Excellence for Risk Analysis, University of Melbourne

This document sets out practitioners' guidelines for ecological impact assessments. They are intended to apply, irrespective of the vagaries of local, state of federal laws and statutes. It represents a significant contribution to environmental management. Such guidelines are the hallmark of mature professional organisations, providing both pragmatic advice and professional credibility.

The guidelines are ambitious, covering the full spectrum of considerations in EcIA, including scoping, determining value, predicting ecological impacts, dealing with uncertainty and significance, and mitigation and management of impacts. Each one of these topics deserves a book in its own right. The challenge has been to distil the essential professional elements of each of these topics, to provide sufficient information for concise professional standards, without being prescriptive. In general, they have succeeded.

Of course, in a project as ambitious as this, there will always be opportunity for improvement. This is a draft document and it will benefit greatly from the careful review of experienced colleagues. Now is the opportunity to shape the document into something that turns the discipline from a loose-knit group of people with similar interests, into a fully fledged profession.

Dr Chris McGrath, Barrister-at-Law, Queensland

I commend the Environment Institute of Australia and New Zealand on proposing guidelines for ecological impact assessment (EcIA), particularly as a component of environmental impact assessment (EIA). I have reviewed the draft consultation document and in my opinion it will be a valuable contribution to improving the consideration of ecological impacts in development assessment and planning in Australia.

EIA in Australia takes many forms and, while legislation rarely prescribes the methodology or sets more than rudimentary standards, a number of guidelines already exist. A perennial problem in EIA is poor consideration of ecosystem effects by failing to properly consider cumulative impacts and by taking a piecemeal approach. In my opinion one of the main benefits of the EcIA guidelines is to emphasise the importance of taking an ecosystem approach to assessing impacts. As noted on page 9 of the draft consultation document, an ecosystem approach is based on an integrated assessment of a project in the context of the dynamic nature of ecosystems, uncertainty and the often unpredictable nature of ecosystem functions, behavior and responses. It inherently requires a consideration of cumulative impacts within a wider ecosystem and planning framework.

I consider that the draft consultation guidelines will be of benefit as a reference document for EIANZ members, the wider profession of environmental consultants and government.

Introduction

Purpose and Context

Ecological Impact Assessment (EcIA) is not in the common or legislative vocabulary of Australia and New Zealand. Whether knowingly or otherwise, ecological practitioners implement EcIA every day and it is not confined to environmental impact assessment (EIA). EcIA is a prominent tool of sustainable development and the profession needs to align itself with an agreeable, consistent and contemporary approach to EcIA, to facilitate better decision-making.

In ecology it is rarely possible, if ever, to prove that a particular outcome will definitely occur so differences in opinion are acceptable traits of an investigation. Variation in judgement may also reflect real environmental variation but opinions are only valid when they are based on appropriate evidence. This means the data that is used to form an opinion must be collected in the right manner. EcIA best practice is addresses inherent uncertainties and other limitations, providing the evidence that is used for expert judgement.

Guidelines for EcIA were first developed by the Institute of Ecology and Environmental Management (IEEM) in the UK were based on well-established best practice and have been adopted or reflected worldwide e.g. in Special Publications of the International Association for Impact Assessment (IAIA). This consultation document draws heavily on the content of the IEEM Guidelines and merges these with IAIA principles and practice.

These days, legislation rarely prescribes the scientific approach for assessments. Even to apply rudimentary legal "minimum" requirements requires methodological foresight. Further, EcIA is not just used in statutory systems like EIA. It applies to all management decisions whether they are part of commercial development, strategic environmental assessment, park or species management. Also, there is an increasing burden on developers to satisfy the requirements of third parties such as insurance companies and banks. For example, where is a compelling case for applying best practice to address requirements of the Equator Principles. Similarly, legislative requirements are rarely enough to satisfy concern from local communities. There are substantial financial and opportunity costs for decisions that would have significant or uncertain consequences for local or indigenous communities.

Ultimately, EIANZ Ecology aims to create *Ecological Impact Assessment Guidelines for Australia and New Zealand,* to support implementation of best practice methods for creating biodiversity outcomes. This requirement has been identified in a number of consultation exercises by EIANZ Ecology.

This document is the first step in that process. EcIA Guidelines would be just one of a range of tools available to biodiversity managers and decision-makers (see Figure 1). The purpose of such guidelines would be to provide a reference, developed by the profession, describing what EcIA is and how it should be done. It should help to:

- improve confidence in the profession's ability to independently and objectively manage environmental standards;

- guide the development of better statutory policy, including better expectation for professional standards;
- improve consistency in EcIA (as a component of EIA), so decision-makers can have more confidence in their decisions;
- fill some of the gaps in policy, where it may not necessarily be prudent to codify standards in law;
- address some of the common difficulties in EcIA;
- ensure that EcIA is given appropriate consideration within the broader EIA process; and
- provide a source of reference for new and upcoming consultants to learn about one of the key components of their trade, for their own professional development.

EIANZ Ecology is a Special Interest Section of the Environment Institute of Australia and New Zealand (EIANZ). The Institute is the peak professional body for environmental practitioners in Australasia, and promotes independent and interdisciplinary discourse on environmental issues. EIANZ advocates that best environmental practice be delivered by competent and ethical environmental practitioners. EIANZ Ecology was set up specifically to provide an Australasian focus on professional standards for practising ecologists.

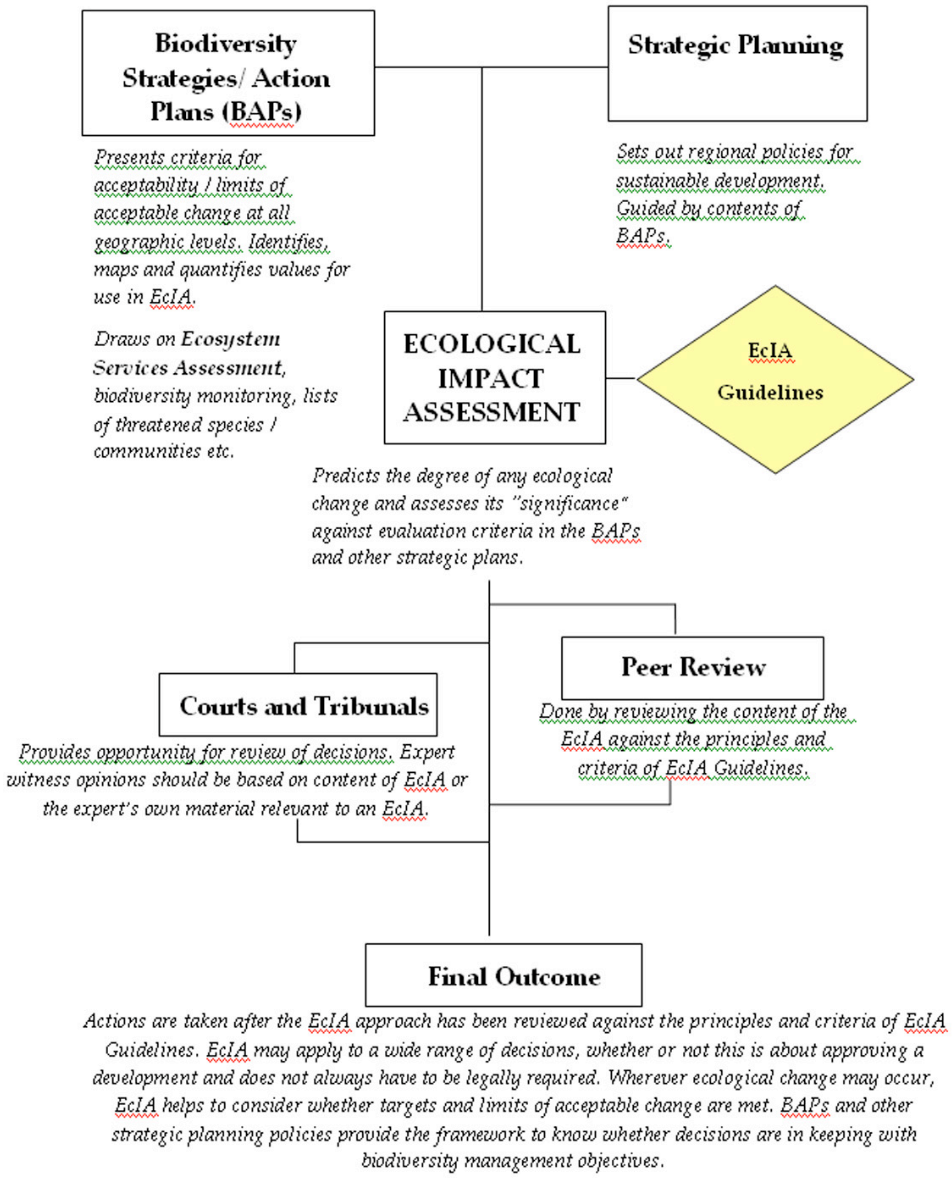

Figure 1. *The role of ecological impact assessment guidelines in biodiversity decision-making.* *There are a range of tools commonly available for biodiversity management and all have a role to play in EcIA. Nevertheless, it is vitally important that EcIA remains independent and objective. Problems can occur when the EcIA is used instead of these other processes, or vica versa. For example, if EcIA is used to determine criteria for acceptable change, or if expert witness opinion is used instead of EcIA. As well as the tools above, EcIA would usually be done alongside relevant social, economic and cultural studies, though some of this information would be expected to form part of the Ecosystem Services Assessment in a Biodiversity Action Plan.*

What is Ecological Impact Assessment?

Ecological impact assessment (EcIA) is an independent, stand-alone, and specific scientific discipline that usually forms an integral part of Environmental Impact Assessment (EIA). Although it is commonly used for individually intensive developments, EcIA might equally apply to monitoring and management of reserves, or more broadly, in the monitoring of biodiversity across whole landscapes - anywhere there is a need to assess changes, including Strategic Environmental Assessment (SEA). EcIA is not just about understanding single topics such as avian mortality or predicting behavioural change in animals, it is about evaluating biodiversity loss, managing the loss and assessing the success of any ameliorative actions.

Treweek (1999) defines EcIA as *the process of identifying, quantifying and evaluating the potential impacts of defined actions on ecosystems or their components; and providing a scientifically defensible approach to ecosystem management.* Impact assessment is defined by the International Association for Impact Assessment (IAIA) as *the process of identifying the future consequences of a current or proposed action. It is used to ensure that policies, plans, programmes and projects are economically viable, socially equitable and environmentally sustainable.*

EcIA is required at the following stages:

- in scoping - a broad assessment is needed which forms the basis for selecting those valued ecological resources to be subject to detailed assessment due to likely significant impacts;
- during the evolution of the project, in order to identify the need for impact avoidance and mitigation and opportunities for enhancement;
- after the mitigation strategies have been fully devised and their likely success considered, the residual impacts are assessed; and
- finally, if significant negative impacts are still likely, it may be necessary to consider the need for and value of ecological compensation. The positive impacts of such compensation proposals should be properly assessed.

As described in *Ecological Impact Assessment* (Treweek, 1999), "*EcIA is firmly rooted in ecological science, drawing on traditional techniques of survey, monitoring, functional analysis and predictive modelling. In addition however, EcIA requires evaluation of the implications of any predicted outcomes. It is this aspect of evaluation which distinguishes EcIA from the pure science of ecology and which has created demand for new approaches to the ways in which ecological information is handled...Ecological outcomes must therefore be translated into a common language or scale for comparison with other findings, whether these are of a social, economic or political nature. In short, EcIA should provide a scientifically defensible rationale for decision making and for environmental management*".

Ecological Impact Assessment and Biodiversity

The IAIA Special Publication No. 3 *Biodiversity in Impact Assessment* says:

> *"biodiversity matters to everyone. Its loss impoverishes the environment and reduces its capacity to support people now and in the future. Impact assessment can help to ensure development is compatible with the conservation and sustainable use of biodiversity".*

- Biodiversity is the total range of variability among systems and organisms.
- Biodiversity is the driver for the planet's life-support systems such as climate, water, nutrient cycles etc.
- Biodiversity provides essential ecosystem services that sustains human capital venture and supports all social, economic and cultural aspects of human existence.

Biodiversity is quantified by applying ecological methods and theory, so ecological impact assessment is the key to understanding biodiversity. Biodiversity (and ecology) are the over-riding factors in EIA / EcIA because biodiversity underpins all other processes that support human existence. Adequate ecological impact assessment is an imperative for sustainable development, because it creates biodiversity management outcomes.

To provide an understanding of how biodiversity is likely to respond to a proposed activity, impacts at each level of diversity can be best assessed in terms of:

- Composition: what biological units are present and how abundant they are;
- Structure (or pattern): how biological units are organised in time and space;
- Function: the role different biological units play in maintaining natural processes and dynamics.

The significance of these responses depends critically on uses and values of biodiversity (IAIA, 2005).

The Principles and Aims of Ecological Impact Assessment

Those involved in EcIA should seek to obtain the best possible biodiversity outcomes from land use changes. It is important that all interested parties can understand the process by which the assessment has been made, and how and by whom any actions needed to deliver biodiversity objectives will be implemented and monitored. Therefore, the EcIA must provide reliable information about, and interpretation of, the ecological implications of any project, from its inception to its operation and, where appropriate, its decommissioning.

It is the role of all ecologists involved in EcIA to:

1. provide an objective and transparent assessment of the ecological effects of the project to all interested parties, including the general public;
2. facilitate objective and transparent determination of the consequences of the project in terms of national, regional and local policies relevant to nature conservation and biodiversity; and
3. set out what steps will be taken to adhere to legal requirements relating to designated sites and legally protected or controlled species, communities.

Principles of EcIA incorporating principles for EIA and for integration of biodiversity in impact assessment are shown in Box 0.

Box 0: Principles of Ecological Impact Assessment (adapted from the IAIA (1999) *Principles of Environmental Impact Assessment Best Practice,* and IAIA (2005) *Biodiversity in Impact Assessment*)

Basic Principles*:*

- **Purposive** - the process should inform decision making and result in appropriate levels of environmental protection and community well-being.
- **Rigorous** - the process should apply "best practicable" science, employing methodologies and techniques appropriate to address the problems being investigated.
- **Practical** - the process should result in information and outputs which assist with problem solving and are acceptable to and able to be implemented by proponents.
- **Relevant** - the process should provide sufficient, reliable and usable information for development planning and decision making.
- **Cost-effective** - the process should achieve the objectives of EIA within the limits of available information, time, resources and methodology.
- **Efficient** - the process should impose the minimum cost burdens in terms of time and finance on proponents and participants consistent with meeting accepted requirements and objectives of EIA.
- **Focused -** the process should concentrate on significant environmental effects and key issues; i.e., the matters that need to be taken into account in making decisions.
- **Adaptive** - the process should be adjusted to the realities, issues and circumstances of the proposals under review without compromising the integrity of the process, and be iterative, incorporating lessons learned throughout the proposal's life cycle.
- **Participative** - the process should provide appropriate opportunities to inform and involve the interested and affected publics, and their inputs and concerns should be addressed explicitly in the documentation and decision making.
- **Interdisciplinary** - the process should ensure that the appropriate techniques and experts in the relevant bio-physical and socio-economic disciplines are employed, including use of traditional knowledge as relevant.
- **Credible** - the process should be carried out with professionalism, rigour, fairness, objectivity, impartiality and balance, and be subject to independent checks and verification.
- **Integrated** - the process should address the interrelationships of social, economic and biophysical aspects.
- **Transparent** - the process should have clear, easily understood requirements for EIA content; ensure public access to information; identify the factors that are to be taken into account in decision making; and acknowledge limitations and difficulties.
- **Systematic** - the process should result in full consideration of all relevant information on the affected environment, of proposed alternatives and their impacts, and of the measures necessary to monitor and investigate residual effects.

Guiding Principles

- **Aim for Conservation and "No Net Loss" of Biodiversity -** biodiversity must be conserved to ensure it survives, continuing to provide services, values and benefits for current and future generations.
- **Take an Ecosystem Approach** - because people and biodiversity depend on healthily functioning ecosystems that have to be assessed in an integrated way, not constrained by artificial boundaries. The ecosystem approach is participatory and requires a long-term perspective based on a biodiversity-based study area and adaptive management to deal with the dynamic nature of ecosystems, uncertainty and the often unpredictable nature of ecosystem functions, behavior and responses.
- **Seek Sustainable Use of Biodiversity Resources** - protect and promote sustainable use of biodiversity so that yields/harvests can be maintained over time. Recognize the benefits of biodiversity in providing essential life support systems and ecosystem services such as water yield, water purification, breakdown of wastes, flood control, storm and coastal protection, soil formation and conservation, sedimentation processes, nutrient cycling, carbon storage, and climatic regulation as well as the costs of replacing these services.
- **Ensure Equitable Sharing** - ensure traditional rights and uses of biodiversity are recognised and the benefits from commercial use of biodiversity are shared fairly. Consider the needs of future as well as current generations (inter-generational needs): seek alternatives that do not trade in biodiversity "capital" to meet short term needs, where this could jeopardise the ability of future generations to meet their needs.
- **Apply the Precautionary Principle** - apply the precautionary principle in any situation where important biodiversity may be threatened and there is insufficient knowledge to either quantify risks or implement effective mitigation. Application of the precautionary principle requires that development

consent should be delayed while steps are taken to ensure that best available information can be obtained through consultation with local stakeholders/experts and/or new information on biodiversity can be obtained/consolidated.

- **Take a Participatory Approach -** consult widely to ensure that all stakeholders have been consulted and that important biodiversity values are taken into account. Valuation of biodiversity can only be done in negotiation with the different groups or individuals in society (stakeholders) who have an interest in biodiversity. Use traditional and indigenous knowledge wherever appropriate. Work carefully with indigenous communities to ensure that knowledge of biodiversity is not inappropriately exploited.

Operating Principles*:*

- **Screening** - to determine whether or not a proposal should be subject to EcIA and, if so, at what level of detail. Use biodiversity inclusive screening criteria to determine whether important biodiversity resources may be affected. Encourage development of a biodiversity screening map indicating important biodiversity values and ecosystem services. If possible, integrate this activity with the development of a National Biodiversity Strategy and Action Plan (NBSAP) and/or biodiversity planning at sub-national levels (e.g., regions, local authorities, towns) to identify conservation priorities and targets.
- **Scoping** - to identify the issues and impacts that are likely to be important and to establish terms of reference. Use as an opportunity to raise awareness of biodiversity concerns and discuss alternatives to avoid or minimize negative impacts on biodiversity.
- **Examination of alternatives** - Examination of alternatives - to establish the preferred or most environmentally sound and benign option for achieving proposal objectives.
- **Impact analysis** - to identify and predict the likely environmental, social and other related effects of the proposal.
- **Mitigation and impact management** - to establish the measures that are necessary to avoid, minimize or offset predicted adverse impacts and, where appropriate, to incorporate these into an environmental management plan or system. Look for opportunities to positively enhance biodiversity. Acknowledge that compensation will not always be possible; there will still be cases where it is appropriate to say "no" to development proposals on grounds of irreversible damage to biodiversity.
- **Evaluation of significance** - to determine the relative importance and acceptability of residual impacts (i.e., impacts that cannot be mitigated).
- **Preparation of environmental impact statement (EIS) or report** - to document clearly and impartially impacts of the proposal, the proposed measures for mitigation, the significance of effects, and the concerns of the interested public and the communities affected by the proposal. Address biodiversity at all appropriate levels and allow for enough survey time to take seasonal features into account. Focus on processes and services which are critical opportunity to raise awareness of biodiversity concerns and discuss alternatives to avoid or minimize negative impacts on biodiversity.
- **Review for decision-making** - to determine whether the report meets its terms of reference, provides a satisfactory assessment of the proposal(s) and contains the information required for decision making. This should be carried out by a specialist with appropriate expertise where biodiversity impacts are significant. Depending on the level of confidentiality of public decision-making, consideration should be given to the involvement of affected groups and civil society.
- **Decision making** - Avoid pitting conservation goals against development goals; balance conservation with sustainable use for economically viable, and socially and ecologically sustainable solutions. For important biodiversity issues, apply the precautionary principle where information is insufficient and the no net loss principle in relation to irreversible losses associated with the proposal.
- **Management, monitoring, evaluation and auditing** - it is important to recognise that all prediction of biodiversity response to perturbation is uncertain, especially over long time frames. Management systems and programs, including clear management targets (or Limits of Acceptable Change (LC)) and appropriate monitoring, should be set in place to ensure that mitigation is effectively implemented, unforeseen negative effects are detected and addressed, and any negative trends are detected. Provision is made for regular auditing of impacts on biodiversity. Provision should be made for emergency response measures and/or contingency plans where upset or accident conditions could threaten biodiversity.

The Process of EcIA

EcIA is a process that follows a series of steps, ultimately finishing in the evaluation of *residual impacts* and any necessary management approaches (Figure 2). The quality of the EcIA is to a very great degree dependent on thorough, inclusive and comprehensive project scoping and a determination of value.

For EcIA to work, each step must be done using procedures that are both rigorous and in keeping with the principles. However, EcIA is also iterative. For example, scoping is an essential prerequisite for viable EcIA but field investigations often reveal additional constraints that may mean revision of the project scope. Although experienced ecologists should closely predict the range of likely constraints, based on a desktop study and personal knowledge of natural history and ecology, this can never be done with 100% certainty. This is why community consultation and fieldwork are both essential and why adequate time needs to be given to preparing assessments in case a second round of fieldwork suddenly becomes necessary.

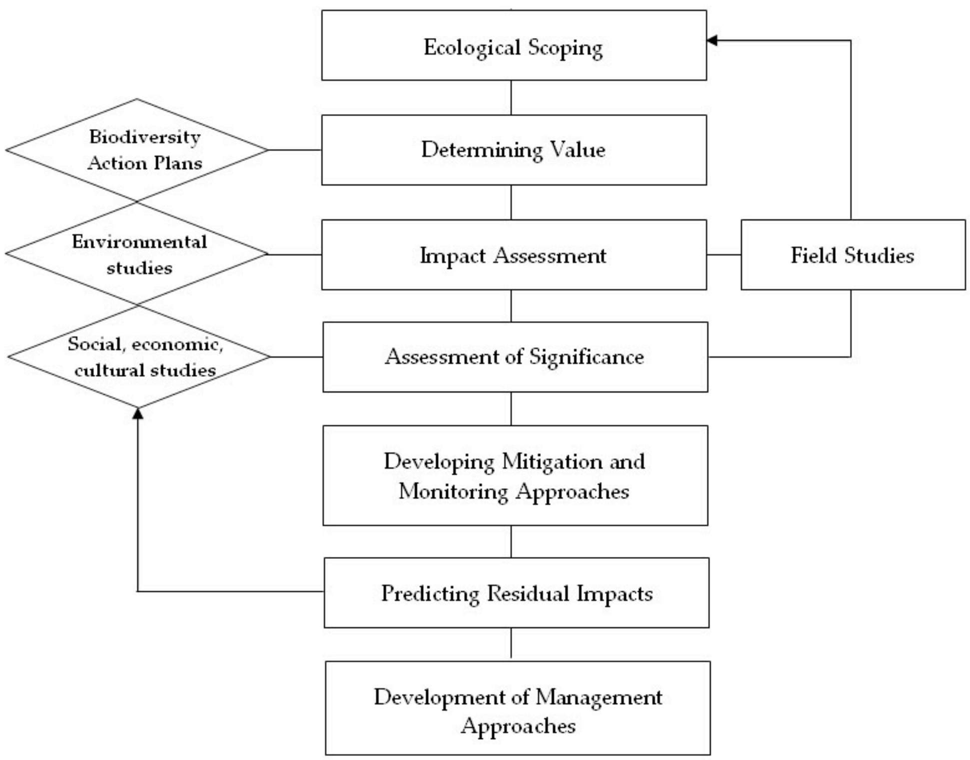

Figure 2: Process of EcIA. *EcIA is central to the assessment of values lost but until investigations begin, the scope of the value is not always known. The scoping process itself is like a mini-EcIA and would draw on the content of BAPs and what is known about human values and ecosystem services. Once full EcIA begins, the impact assessment field studies may reveal additional constraints that require the scope to be revisited. Also, other environmental studies, such as contaminated land, water quality etc., may reveal vulnerabilities and these can have ecological consequences with social, economic and cultural knock-on effects. This too may result in an iteration of the scoping phase and further investigation. One of the final steps of the EcIA process is to determine residual impacts and this information needs to feed into social, economic and cultural studies, so the final ecological significance can be determined.*

We have split EcIA into four phases: Preparation, Prediction, Mitigation and Net Gain / No Net Loss. EcIA is most commonly associated with predicting impacts but the other phases are vital to the integrity of the process, especially if the aim is to create a no-net-loss outcome. As discussed above, the creation of biodiversity outcomes is increasingly demanded by governments, companies, community groups and financiers, even in the absence of specific legislation.

In each of the following sections, we describe recommended methods of approach that are consistent with best practice.

Ecological Assessment - Preparation

Scoping

Introduction

Ecological Scoping is about EcIA design. More specifically, it is to determine the range of constraints required to be submitted to a responsible authority.

The process of scoping is essential to all EcIAs. It helps to clarify key issues and promote dialogue with consultees and other stakeholders concerning key ecological issues and proposed methods for survey, evaluation and assessment.

Key benefits of scoping include:

- early stakeholder input, so issues of concern are identified and dealt with at an early stage;
- an assessment focused on likely significant impacts;
- clear terms of reference for all ecologists involved in the EcIA, including an understanding of the criteria that will be used to evaluate the significance of their findings; and
- early identification of the need for seasonally dependent surveys so that they can be accommodated in scheduling.

As discussed above, there is an increasing requirement for projects to achieve biodiversity benefits, not simply to avoid negative impacts. The scoping process can provide a good, early opportunity for ecologists to work together to achieve these objectives and lays the foundations for the whole consultation and assessment process. For example, with planning foresight, the EcIA process can be used to develop the vast majority of a biodiversity offset program, if such a program does not already exist in the regional legislation.

It is widely accepted good practice for the results of scoping to be presented as a formal report or letter. Such a document is valuable for any project that requires detailed ecological survey, particularly where stakeholder-input is essential in defining terms of reference acceptable to all parties. Circulating this document and agreeing the terms of reference for an EcIA with community and other important stakeholders well in advance, avoids otherwise inevitable conflict at the approvals stage.

It is important to recognise that the proposed scope of an EcIA may change following the preparation of a scoping report/letter. This may be in response either to requirements or concerns identified by statutory or other consultees, or to changes in the project’s design or available environmental information. It is good practice to report the final scope of the assessment within the EcIA report.

The Scoping Process

Overview

Scoping should be seen as a flexible, adaptive and iterative process, usually based on preliminary consultations, literature searches, site-visits and preliminary ecological surveys.

Scoping may be considered more effective when results are already available from preliminary ecological surveys, or it may be seen as a mechanism for stakeholders to guide the design and implementation of such surveys. There is no set formula, but it should include the elements identified in Box 1. If scoping commences at an early stage in the assessment, it may be necessary to delay the completion of some of these elements, until adequate information has become available. More information on each of the stages described in Box 3 is provided in subsequent sections.

Box 1: Stages in Scoping

Proponent's ecologist to:

- obtain information about the project from the proponent or their engineers / designers;
- dentify project activities likely to cause ecological damage, stress or disturbance. Obtain any available information about their spatial extent, timing, frequency and duration;
- concurrently, identify opportunities for enhancing biodiversity and delivering biodiversity objectives;
- identify stakeholders, consultees and all ecologists who should be involved and establish a consultation strategy;
- produce a scoping report as a basis for further consultation with the competent authority, statutory consultees and others involved in the consultation strategy; and
- refine the scope of the assessment based on feedback on the scoping report. Continue to refine the scope - scoping out potential impacts that are no longer considered likely to be significant and addressing newly identified impacts that are likely to be significant. The final scope provides the terms of reference for the remainder of the EcIA.

All stakeholders to:

- identify relevant legislation, regulations and policies and review their requirements. This may include the need for a licence before some activities can go ahead;
- develop an understanding of the ecological context based on existing ecological information, data gathering, literature searches, site visits and any baseline studies already carried out;
- determine a threshold for selecting ecological features to be included in the assessment, based on their value (see Determining Value);
- identify those ecological resources reaching the threshold value which could be affected by the project;
- identify the factors affecting the integrity of the relevant ecosystems and the conservation status of relevant habitats and species;
- identify ecological features likely to be significantly affected and therefore requiring further study and explain the selection criteria used;
- consider potential sources of cumulative effects;
- consider alternatives including the best environmental option;
- agree details of proposed survey / research methodologies. Confirm the study area and the criteria that will be used to assess its nature conservation value; and
- consider potential mitigation/enhancement or compensation opportunities.

Information about the project

The first step is to review proposed activities and identify those likely to cause ecological impacts or deliver biodiversity enhancements: what are the proposed activities; where and when will they take place; are they permanent and if not, how long will they last; and what biophysical changes are they likely to cause? Activities may differ throughout the lifetime of a project, so identify activities associated with construction, operation (best and worst-case operating conditions), decommissioning and restoration as appropriate. If possible map the location of infrastructure and the distribution of the related activities. Identify areas and resources that may be affected by the biophysical changes caused by the identified activities, however remote from the project site, to identify the zone of influence (see Box 2). The zone of influence should be continually reviewed and if appropriate, amended as the scheme evolves. If inadequate information is available to properly define the zone of influence, this should be acknowledged.

Box 2: Example illustrating factors to consider when defining the zone of influence of a proposed quarry

- All ecological features or resources occurring within the area to be worked will be affected by changes in land cover caused by topsoil stripping and excavation.
- Noise, dust and changes in human activity will also affect species in adjacent habitats.
- If the quarry involves major, long-term dewatering operations, there could be consequences for water-dependent habitats that are many miles from the quarry. It may not be possible to determine the zone of influence of dewatering without undertaking hydrological/hydrogeological modelling. The zone of influence should include all water-dependent receptors that could be significantly affected by the predicted draw-down, providing they are of sufficient value to be considered in the assessment (i.e. they are above the defined threshold value).
- If the quarry requires new infrastructure (e.g. roads, power supply or waste water disposal) there could be significant consequences for ecological features beyond the boundaries of the site in addition to those affected by dewatering. The zone of influence should include all such features that are of sufficient value to be included in the assessment.

It can be difficult at the scoping stage to establish the full extent of changes caused by a project, in which case it is better to err on the side of caution to ensure that the study area incorporates all areas where impacts could occur.

The information likely to be required about a project is summarised in Box 3. For projects that require EIA, reference should be made to the relevant schedules in the EIA Regulations, which specify information about the project that should be included in an ES. Examples of activities that may generate ecological impacts are given in Box 4.

Box 3: Information about the project

A wide variety of information is required to carry out EcIA effectively:

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- location, size, extent and spatial organisation of infrastructure and activities;
- lifetime of project including decommissioning;
- activities likely to cause ecological impacts during construction, operation and decommissioning, their timing, duration, location, extent and magnitude, e.g. emissions (type, volume, range), construction activities, etc. (see Box 4);
- activities designed to deliver biodiversity enhancements;
- 'impact zones' or 'effect areas' for main activities;
- receiving environment or 'pathway' for emissions (e.g. water, soil or air); and

- best and worst case operating conditions.

To define the baseline / existing conditions that are expected to occur at the time that the development takes place and to address cumulative effects, it is necessary to consider:

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- environmental trends;
- completed developments; and
- other developments for which consent has been granted.

Further information about the definition of baseline / existing conditions and cumulative impact assessment is included the section on Impact Assessment Prediction.

- To assess the impacts of alternatives the following information will be needed:
- alternative sites;
- alternative designs;
- alternative processes; and
- alternative means of meeting objectives of the project.

Box 4: Examples of activities likely to generate impacts

Preliminary activities prior to the main construction contract (e.g. ground investigations)

Construction phase

- Access and travel on/off-site.
- Assembly areas for components of construction.
- Blasting, e.g. for minerals operations.
- Construction of structures and hard surfaces.
- Demolition operations.
- Environmental incidents and accidents (e.g. spillages, noise and emissions).
- Fires.
- Ground and excavation works.
- Lighting.
- Provision of services and utilities (e.g. underground power lines, water supply and drainage).
- Removal or disruption of top-soil/sub-soil etc.
- Siting and subsequent removal of site offices/compounds and final site clear away after
- construction.
- Storage areas for construction materials.
- Structural works for building and engineering.
- Structural works to existing buildings, including conversions.
- Temporary access routes for construction vehicles - both on and offsite.
- Vegetation clearance.

Occupation/Operational phase

- Access (both route and means).
- Drainage.
- Damage to mitigation work through accident or vandalism.
- Implementation of landscape design and habitat management (type and location).
- Presence of people, vehicles and typical uses and activities (including factors likely to cause disturbance, e.g. increased public access and recreational pressure, risk of fires, lighting, noise, regular emissions).
- Presence of pets.
- Site operation and management (e.g. maintenance operations, industrial processes generating emissions, etc.).

Decommissioning phase

- Removal of contaminated water or soil.
- Removal or demolition of disused structures that may have been colonised by, e.g. roosting animals.
- Removal of ancillary developments including culverts.
- Removal or neglect of structures which might cause pollution if they fail.
- Restoration phase (where operations/phases have finished, e.g. for mineral extractions).
- Potential non-standard operations (e.g. one-off incidents and accidents).

Based on Oxford (2001).

Stakeholders, consultees and key players

At an early stage, the responsible authority and the proponent's ecologist should review the requirements for ecological input and any other specialist skills that are needed to undertake the EcIA. In undertaking this review, consideration should be given as to who will finally advise the responsible authority on the ecological consequences and possible environmental liability resulting from the project. Consideration should also be given to the important role of statutory and non-statutory ecological consultees in providing not only site-specific data but also contextual information and local expertise.

At an early stage in the EcIA, it is also advisable to engage ecological consultees in discussions over possible project alternatives, in order to help in identifying the alternative(s) that are likely to cause the least ecological damage or greatest benefits. Consultation will allow discussion about the scope and methods of any investigations that may be needed to investigate alternatives. Involvement of the public is good practice in situations where significant impacts are likely on wildlife resources and landscapes known to provide benefits to local communities.

It is desirable for the scoping report (or letter), which summarises the findings of the scoping work undertaken up to that point, to be circulated for discussion amongst consultees. Scoping workshops may be considered, to provide all major stakeholders with an opportunity to discuss a project and reach consensus on the scope of the assessment. This can significantly reduce consultation time and avoid delays caused by stakeholders requesting additional survey or other work at a later stage. All agreements on the scope of ecological survey work should be confirmed by the parties concerned in writing, at as early a stage as possible, ideally before initiating the survey and assessment work that has been proposed.

There should be some preliminary discussions about potential strategies to provide biodiversity benefits and avoid, minimise or offset any negative impacts. This will enable the preparation of such strategies to concentrate on those approaches most likely to meet with stakeholders' approval.

In judging whether the effects of a development are likely to be significant, responsible authorities should always have regard to the possible cumulative effects with any existing or approved development. Cumulative impact assessment is discussed in the section on Impact Prediction. The detailed approach to be taken should be agreed between all parties concerned during scoping.

Legislation and policy requirements

It is important to consider relevant legislation, regulations and policies at an early stage, as they may have a bearing on the required scope of investigations, how impacts should be interpreted, or the criteria that need to be used for determining significance.

Ecological resources affected - establishing the baseline

Having defined the zone of influence (see above), there is a need to investigate the ecological resources that could be affected by the project.

Direct impacts on part of a habitat or population/assemblage may have implications for the whole habitat or population and the study limits should be adjusted accordingly. Furthermore, species may have different vulnerability distances and periods, so the spatial scope of studies must also vary.

For example, if the zone of influence impinged on the breeding territory of a sub-population of a given bird, it would be necessary to consider the implications of localised impacts in relation to the birds' wider population. If there were a number of sub-populations in the area, then it might be appropriate to restrict the study to the specific sub-population of birds affected. However, if the birds were at the edge of their range, or the sub-population affected was an important link in the distribution pattern, then it might be necessary to consider implications for the regional, or even the national population.

Impact assessment should always be done in the content of the the biodiversity landscape and not just in relation to the site or its immediate periphery. The geographic context of the assessment varies depending on what is being considered.

Consideration needs to be given to what constitutes the baseline, as it may not be the same as the conditions at the time of the assessment. In order to determine this, it is necessary to try to predict any changes that will alter conditions prior to the start of the proposed construction and subsequent to it (see Box 5). There may be overlap between establishing the baseline in this situation and considering cumulative impacts that might be expected (see Impact Prediction). This should be determined through discussion between relevant stakeholders in the EcIA process.

Box 5: Example illustrating setting the baseline

A power station drawing cooling water from a river is to close down, due to a rationalisation of the power supply network. During the time in which the power station has been in use, the riverine invertebrate, fish and bird assemblages in the immediate vicinity of the power station have adapted to reflect local, increased temperatures caused by the regular discharge of heated river water. Closure of the power station will mean that this discharge will stop.

Once closed, it is proposed to convert the power station building to residential units. For reasons of timing, the EcIA for the residential development must be undertaken prior to closing down the power station.

In this instance, the baseline for the EcIA of the conversion to residential use is the predicted post- closure situation, rather than that evident at the time of undertaking the EcIA. The surveys and investigations to describe the baseline must be designed to enable the likely post-closure situation to be predicted as accurately as possible.

Additionally, it may be appropriate to consider the variation in a population over time, rather than take a single year's data as an accurate reflection of the situation.

The results of professionally accredited or published scientific studies should be used, where available, to establish the likely spatial and temporal limits of ecological impacts for specific activities and to justify decisions made at the scoping stage.

Study boundaries should be drawn to include any areas that are affected, both directly or indirectly. For example, with major roads, the zone of direct disturbance could extend up to 1 km on either side. If indirect effects are also taken into account (e.g. the effects of displaced individuals on the occupancy of alternative habitat), then the 'effect zone' could be considerably larger. Box 6 provides a summary of the information required to establish the spatial scope of baseline studies.

Box 6: Considerations relevant to establishing baseline / existing conditions for ecological resources within the zone of influence

Designated sites

- Are there any sites designated for nature conservation that fall within the zone of influence?
- Does the project affect any sites likely to be designated in the foreseeable future?
- Is there any policy presumption in favour of habitat protection/creation/restoration in the area?

General ecological considerations

- What ecological features at or above the defined threshold level of value may occur within the zone of influence?
- What are their distribution and status elsewhere for comparison?
- What were their historical distributions, status and management compared with the present?
- What are their scales of variation, vulnerability and likely exposure to the project?
- What are the key ecological processes or species activity periods; are there seasonal variations in distribution, abundance and activity?
- Are there any species, the disappearance of which would have significant consequences for others?
- Are there any other projects planned within the same area or time-frame that may contribute to cumulative effects?

Contextual information is essential to confirm spatial and temporal scope. Such information may be available from the ecological consultees and in any relevant local and national biodiversity plans. Adequate time and resources should be allowed to undertake such vital contextual research. These references will also provide the information required in order to value ecological receptors (see Determining Value).

A 'Phase 1' habitat survey of the zone of influence should be undertaken. The survey should use established methodologies. The habitat survey will identify the main communities and habitat types that may be affected by the project and provide a documented basis for determining the scope of more detailed surveys.

If it is not feasible within the context of a given project to gain access to land beyond the project site, it should be possible to undertake a simple Phase 1 survey from public highways or other accessible public spaces in the zone of influence. The survey limitations should be described and their effects on the confidence in the conclusions should be assessed.

For assessments with a wide geographic coverage (e.g. for proposed roads or pipelines), it may be worth buying aerial photographs or satellite images or even commissioning new ones. These can provide insights into spatial relationships, so that the impact assessment can be designed to 'capture' ecological distributions, processes and interactions at an appropriate scale.

Selecting ecological resources and issues requiring detailed assessment

As it is impossible to investigate all issues in detail, it is necessary to focus further study on those likely to generate significant ecological impacts (negative or positive). This is consistent with the most EIA regulations, which only require investigation of likely significant effects. The rationale and criteria used to select certain aspects for more detailed study (and others excluded from further investigation) should be agreed and documented during scoping.

Issues to consider when selecting ecological resources for further investigation include the following:

a. Whether the feature or resource is sufficiently valuable for an impact to be significant in terms of biodiversity, social/community value and/or economic value; legal protection needs to be considered separately. A clear rationale should be developed for deciding the threshold above which features and resources should be subject to more detailed consideration. This should be based on the value of features, measured as described in Determining Value. This will enable all those involved in the assessment to understand the reasoning behind the scope of the investigations. Policy considerations will influence the criteria that will be appropriate for determining the threshold in any particular case.

b. Whether the feature or resource is likely to receive a significant negative impact.

These issues are discussed in more detail in Determining Value and Impact Prediction respectively, where guidance is provided on methods for identifying important sites, habitats or species and determining whether impacts are significant.

Detailed survey and research requirements

Having completed the initial scoping work, which is normally based on existing data sources and a habitat survey of the zone of influence, it should be possible to identify any additional data required to predict impacts more fully. This may involve updating existing data. The geographic coverage and timing of further ecological studies should be agreed at the scoping stage. These can be revised later if necessary, as progressively more information becomes available through the assessment process.

Terms of reference for additional studies are based on:

- information on ecological resources within the zone of influence;
- the timeframe for all phases of the project; and
- information gaps/survey needs that should be addressed in order to assess impacts and their significance.

Standard survey methods should be used wherever appropriate, so that results can be compared with those arising from other investigations. Details of how methods have been tailored to meet the needs of the study should be included. If the method used varies from accepted good practice this should be noted and the effect on the reliability of the results discussed.

Determining Value

This chapter provides guidance on how to assign values to ecological features and resources. There is no equation for determining the value of an ecological asset. Its depends on an integration of factors and the strength of each varies on the merits of the particular situation. Valuation has to be done by first identifying then teasing apart these different factors.

Values can never be guessed via the opinion of an individual ecologist or institution as their very nature is socio-political. Value judgements can only be based on a pre-existing standard of social, cultural, economic or biodiversity importance. This might include documentation about the dollar value of tourism, the perceived importance of ecosystem services (e.g. water quality, rainfall, erosion), the existence of public land such as reserves, the whether a species is protected (as a component of biodiversity processes), or indigenous spiritual needs.

The valuation process is critical to the integrity of EcIA and must be done prior to predictions of significance in the impact assessment. This would usually be as part of a National Biodiversity Strategy Action Plan, otherwise known just as a Biodiversity Action Plan. Development of such plans is recommended in IAIA principles for biodiversity in impact assessment . The values that are identified are biodiversity value, social/community/indigenous value and economic value. Legal protection needs to be considered separately from value. Features that are important for social/community/indigenous or economic reasons should be identified as part of the assessment of the socio-economic or community effects of a project. Values may be direct e.g. the value of a resource taken from the environment, or indirect e.g. the value of ecosystem processes in supporting ecosystem integrity and human health. The socio-economic value of these features may require a landscape-scale understanding of ecology but the significance of any impacts will then be determined by the socio-economic/community specialist.

The value that is attached to an ecological resource influences:

- whether, as part of screening, potentially affected features or resources are considered sufficiently valuable that there could be a significant effect that would trigger an EIA;
- whether, as part of scoping, ecological features or resources are considered for inclusion in the EcIA - this is influenced by their value in relation to a 'threshold' level of value that should be defined during scoping;
- deciding what mitigation is appropriate.
- considering legal and policy implications.

Guidance on EcIA tends to set out categories of ecological or nature conservation value that relate to a geographical framework (e.g. international, local) together with examples of the ecological features or resources that qualify for each category. It is generally straightforward to evaluate designated sites against specific categories (e.g. National Parks and Ramsar sites); although for sites of local value these may not be predetermined. Plus, within protected areas, there may be values that are separately relevant to local communities. The same problem applies to evaluating habitats and species.

Ecosystem Services

Many of the values discussed in the following sections may be expressed as Ecosystem Services. Ecosystem services are benefits that humans draw from the environment and there is a direct relationship between human health, welfare and sustainability e.g. if biodiversity value drops, then natural resources decline and our economy suffers as much of what we do depends on trading natural capital. Ecosystem services that derive from habitat and species include things like forestry, fisheries, tourism and spiritual values. These are directly beneficial to humans and easily perceived if not valued in quantitative terms. However, some of the most important ecosystem services are those that support and regulate the environment, such as water quality and atmospheric carbon cycles. These are much more difficult to quantify but should not be overlooked. For example, the cumulative impact of land clearance is one of the drivers of climate change. The principles of reversing biodiversity loss (see Box 0) are aimed at addressing these serious problems. Their value should not be underestimated.

Ecologists should be proactive in identifying situations where specialist economic / indigenous / other cultural input might be required. This will ensure that implications of ecological change are properly included in an assessment. Ecologists may need to work together with other scientists to identify important resources. The ecologist will be responsible for describing the ecological changes resulting from the project, which an economist, social scientist or indigenous culture expert will use to assess the economic impacts in qualitative or, preferably, quantitative terms.

Any economic appraisal should be open to consultation as soon as possible, with the methodology presented transparently so that stakeholders can give a view on the values assigned.

Social and Indigenous Value

People derive benefits from biodiversity in various ways, including:

- critical life support offered by ecosystem processes;
- a population of a species that is enjoyed each year by large numbers of local people or visitors;
- a population of animals that are valued visitors to gardens in a large number of adjoining gardens or schools;
- spiritual significance of a site or its wildlife;
- formal recreational enjoyment of hunting or fishing;
- health aspects;
- informal recreational activity e.g. countryside walks;
- sites that provide the only visually and/or physically accessible area of semi-natural green-space for a local community; and
- use of habitat areas for the purpose of learning about wildlife.

The extent to which a site and its wildlife provide a resource that people use or enjoy often informs the designation of reserves. In such cases, the social or indigenous value that is attached to a site may be defined on the basis of the level of importance at which the site has been designated (e.g. state, shire, etc.). In other circumstances, it may be necessary to make a judgement about the value of the site based on other criteria, such as the extent to which the site is used by local people and others and the availability of other accessible green space in the vicinity.

It should be noted that even where designation systems reflect social values, they may not have involved a comprehensive survey of the social value of all the relevant areas. As a result, an EcIA, EIA or other social/environmental studies may identify previously unrecognised (and un-designated) sites of social or indigenous importance.

The social or indigenous effects of a project that might affect a local site that has been designated partly for social reasons are often neglected in EcIAs, as no one member of the team may feel able to fully address the issues. Effects on socially valued are even more likely to be neglected. To avoid this situation, it may be useful to separate 'social values' from those specifically related to the conservation of biodiversity in order to ensure that all potentially significant values are recognised. Wherever possible, subjective judgements about social value should be supported by quantitative data and surveys of opinion by local residents if the issue is sufficiently critical.

Having identified the important sites/species, the ecologist should carry out the assessment of how the ecology of these sites/species might be affected by the project. Ideally, a sociologist would then make the assessment of the social consequences of the ecological changes. Information about social impacts can then be considered alongside biodiversity impacts in developing mitigation/compensation/enhancement measures, in determining the significance of impacts and, ultimately, in the decision-making process.

Care should also be taken to ensure that short-term social needs do not over-shadow the need to protect the long-term integrity of the environment. The indirect and cumulative costs of land clearance, for example, may be greater than the benefits derived from short-term timber harvesting.

Economic Value

Direct economic implications may result from impacts on certain ecological features and resources that are financially valuable, for example:

- paying visit to nature reserves;
- populations of fish for angling;
- populations of shell fish in estuaries;
- rare breeding birds at publicly accessible breeding sites that attract large numbers of overseas visitors, who bring economic benefits to the local economy;
- areas where hunting or stalking takes place; and
- urban green space might play a valuable role in contributing to the health and wellbeing of local communities with consequent economic benefits;

Criteria relating to economic value typically reflect considerations such as the contribution to the economy derived from the ecological resource, e.g. the number of jobs that are supported. These need to be considered in relation to direct 'upstream' and 'downstream' economic activities. This would normally be done in the context of values adopted in the wider socio-economic assessment. Guidance on this subject is beyond the scope of this document.

Geographic Frame of Reference

The value or potential value of an ecological resource or feature should be determined within a defined geographical context. It is recommended that the following frame of reference be used (or be adapted to meet local circumstances):

- International;
- National (e.g. New Zealand / Australia);
- Regional (State, Territory or Island);
- District or Catchment Management Area;
- Local Shire; or
- within zone of influence only (which might be the project site or a larger area).

In some EIAs (or other integrated assessments), the ecologist may be required to use other approaches to assigning levels of value (in order to be consistent across different technical subjects). In such cases, it is often helpful for the prescribed terms to be translated into the geographical scale that is set out above, so that the legal and policy consequences of any significant impact can be clearly understood by all ecologists.

Designated Sites and Features

Some sites have already been assigned a level of nature conservation value through designation. The reasons for this designation need to be taken into account in EcIA e.g. the Ramsar Information Sheets for Wetlands of International Importance, or the Management Plans for National Parks and Reserves.

Where a feature has value at more than one level, its overriding value is that of the highest level but the features for which the site has been designated at each level may differ and should be valued accordingly. Features of the site that are not the reasons for its designation(s) may need to be assessed and valued according to their intrinsic or other value.

Measuring Biodiversity Value

Overview

The value of areas of habitat and plant communities at given geographic scales, should be measured against published selection criteria where available. These documents vary considerably from place to place. Some parts of Australia and New Zealand have completed habitat benchmarking for regional vegetation classes and have existing, sophisticated calculators for determining value based on structure, species and extent of cover at pre-European settlement. Biodiversity Action Plans, or their equivalent, might also provide an indication of habitats that are considered important at the local scale.

Where there are no published selection criteria, for example in most of the marine environment or in poorly mapped regions, it may be necessary to estimate value based on particular criteria. The following criteria are well-established for assigning conservation value in any habitats. For example, they have been used in the selection of Marine Protected Areas (ANZECC, 1998):

Representativeness

- Does the area represent a substantial proportion one or more ecosystems within a bioregion and to what degree?

Ecological Importance

Does the area

- contribute to the maintenance of essential ecological processes or life-support systems;
- contain *habitat* for rare or endangered species;
- preserve genetic diversity i.e. is divers or abundance in species;
- contain areas on which species or other systems are dependent e.g. contain nursery or juvenile areas or feeding, breeding or resting areas for migratory species; or
- contain a substantial part of a landscape that is a biologically functional, self-sustaining ecological unit?

International, national, regional or local importance

- Is the area rated, or has the potential to be listed on any relevant conservation agreement or policy from the international to local level?

Uniqueness

Does the area

- contain unique species, populations, communities or ecosystems;
- contain unique or unusual geographic features?

Productivity

- Do the species, populations or communities of the area have a high natural biological productivity?

Vulnerability

- Are the ecosystems and/or communities vulnerable to natural processes?

Biogeographic Importance

- Does the area capture important biogeographic qualities?

Naturalness

- How much has the area been protected from, or not been subjected to human-induced change?
-

Other characteristics that can be used to identify ecological resources or features likely to be important in terms of biodiversity include:

- habitat diversity, connectivity and/or synergistic associations;
- notably large populations of animals (e.g. shorebirds) or concentrations of animals considered uncommon or threatened in a wider context;
- plant communities (and their associated animals) that are considered to be typical of valued natural/semi-natural vegetation types - these will include examples of naturally species-poor communities;
- species on the edge of their range, particularly where their distribution is changing as a result of global trends and climate change; and
- typical faunal assemblages that are characteristic of homogenous habitats.

Consultation, especially with local specialists, can be crucial for identifying less obvious important resources and features.

The relative ecological importance of different ecological features and resources in the landscape may also change in response to changing conditions. For example, climate change could increase the need for large-scale habitat networks that are designed to maintain important biodiversity processes, such as pollination or seed dispersal by land birds and invertebrates.

Valuing Species

This part of the guidance deals with species that need to be assessed because they are of biodiversity value rather than because they are legally protected (although some species may fit in both categories).

In assigning value to a species, it is necessary to consider its distribution and status, including a consideration of trends based on available historical records. A non-mobile species can generally be assumed to occur regularly on a site, even after just one recent reliable record. However, records over a longer period, for example five years, may be needed for mobile species or species that are in rapid decline. The occurrence of species that are not typical of the habitat from which they have been recorded should be investigated in greater detail. Due to sheer size and lack of high resolution data on species in Australia and New Zealand, a precautionary approach based on habitat assessment may also be prudent.

The valuation of populations should make use of any relevant published evaluation criteria.

For example, criteria for defining nationally and internationally important populations of waterfowl under the Ramsar Convention.

Rarity is an important consideration because of its relationship with threat and vulnerability of habitats. Some species are inherently rare, so it is necessary to look at rarity in the context of status. A species that is rare and declining may be assigned a higher level of importance than one that is rare but known to be stable. Other rarity-related evaluation criteria include the need to protect populations where Australia or New Zealand holds a large or significant proportion of an international species, especially endemic species.

There are numerous species whose populations are in decline throughout Australia and New Zealand. Those for which the decline is most serious, may be the subject of action plans / action statements / recovery plans / biodiversity action plans ("action plans"). As with habitats, the existence of an action plan or its equivalent should reflect the fact that the species' habitat is in a sub-optimal state. Note, just because an action plan exists for a species does not imply any specific level of value for the species (in the same way as an absence of an action plan does not imply a total lack of value). The value of the population of a species should be determined using the same approach as with other species (above). Likewise, inclusion of species in lists of declining species (e.g. critically endangered, endangered, vulnerable) is not in itself a sufficient criterion for assigning a level of value to the species concerned. This is because such lists include species in decline for a number of different reasons and ecological value can vary between listed species.

Multi-functional Features

Some habitats or species may have biodiversity, social and economic value. In this instance, the impact of a project on all three aspects should be assessed separately before an integrated assessment is carried out.

Legal Issues

The approaches described above should be used to evaluate the biodiversity value of a feature in order to provide advice on the policy implications of any impacts. In addition to this approach, EcIA must demonstrate how the project being considered will be taken forward such that the legal requirements will be met. It should be noted that for some projects, features may be of insufficient biodiversity, social or economic value to merit assessment within an EcIA (e.g. because they are below the defined threshold for biodiversity value) other than the need to consider them within the context of the relevant legislation.

A common example of the above, is the need to consider legally controlled weeds and other pests. The presence of such species may be assessed as being an ecological, social or commercial disbenefit, although they may have some ecological merit. Advice should be provided on the legal consequences of their presence and the ecological impacts assessed in this context.

Impact Assessment - Prediction

Introduction

Assessment of ecological impacts is required at the following stages:

- in scoping - a broad assessment is needed which forms the basis for selecting those valued ecological resources to be subject to detailed assessment due to likely significant impacts;
- during the evolution of the project, in order to identify the need for impact avoidance and mitigation and opportunities for enhancement;
- after the mitigation strategies have been fully devised and their likely success considered, the residual impacts are assessed; and
- finally, if significant negative impacts are still likely, it may be necessary to consider the need for and value of compensation / offsets. The positive impacts of such proposals should be properly assessed.

The starting point for any assessment is to determine which ecological features or resources within the zone of influence are both of sufficient value to be included in the assessment and vulnerable to significant impacts arising from the project. The determination of value should make use of the guidance here. The rationale for selecting features for inclusion in the EcIA will differ, depending on the situation, and so, ideally, it should be agreed through consultation during scoping. For those ecological resources or features that are to be included in the assessment i.e. have been 'scoped in', the next step is to describe the changes to the baseline / existing conditions likely to arise from the project and the resulting ecological impacts. If, at scoping these impacts are considered likely to be significant, they should be investigated further and clearly described in ecological terms, before the legal, policy, social or economic implications are considered.

Description of Baseline / Existing Conditions

Baseline conditions or 'existing conditions' are usually described for the time of the development. However, it may also be necessary to consider the conditions as they might be when the project is due to begin. For example, if a coastal development is not due to start for 5 years, the predicted ecological impacts may be greater than if the development were to start now, if during the intervening period there is a rise in sea level.

Similarly, it may be necessary to consider the implications of other developments that would occur. As a minimum, baseline / existing conditions would normally include developments that have been approved even if these have not yet proceeded. It is important therefore, that consultants are given adequate resources and information about existing or predicted pressures. This ensures that cumulative impacts are properly addressed.

Predicting and Characterising Ecological Impacts

Having identified the activities likely to cause significant impacts (see scoping), it is then necessary to describe the resultant changes and to assess the impact on valued ecological resources. It will be necessary for the proponent's ecologist to liaise with other members of the proponent's team as the changes to be considered may relate, for example, to noise, air quality, hydrology or water quality.

This guidance recommends that the process of identifying impacts should make explicit reference to aspects of ecological structure and function on which the feature depends. Some of the elements that may be considered are identified in Box 7.

Box 7: Examples of aspects of ecological structure and function to consider when predicting impacts

Available resources

- Territory: hunting/foraging grounds; shelter and roost sites; breeding sites; corridors for migration and
- dispersal; stop-over sites.
- Food and water (quantity and quality).
- Soil minerals and nutrients and hydrochemistry.
- Solar radiation and gaseous resources.

Stochastic processes

- Flooding, drought, wind blow and storm damage, disease, eutrophication, erosion, deposition and other geomorphological processes, fire and climate change.

Ecological processes

- Population dynamics: population cycles; survival rates and strategies; reproduction rates and strategies; competition; predation; seasonal behaviour; dispersal and genetic exchange; elimination of wastes.
- Vegetation dynamics: colonisation; succession; competition; and nutrient-cycling.

Human influences*

- Animal husbandry, cutting, burning, mowing, draining, irrigation, culling, hunting, excavations, maintenance dredging, earth shaping, ploughing, seeding, planting, cropping, fertilising, pollution and contamination, use of pesticides and herbicides, introduction of exotics, weeds and genetically modified organisms and disturbance from public access and recreation, pets and transport.

Historical context

- Natural range of variation over recorded historical period.
- Irregular perturbations beyond normal range (such as very infrequent storm events).

Ecological relationships

- Food webs, predator-prey relationships, herbivore-plant relationships, herbivore-carnivore relationships, adaptation, and dynamism.

Ecological role or function

- Decomposer, primary producer, herbivore, parasite, predator, keystone species.

Ecosystem properties

- Fragility and stability, carrying capacity and limiting factors, productivity, community dynamics.
- Connectivity.
- Source/sink.
- Numbers in a population or meta-population, minimum viable populations.
- Sex and age ratios.
- Patchiness and degree of fragmentation.

* Note: Many of our semi-natural habitats and wild species have co-evolved with humans and are adapted to management practices that now sustain their current conservation status.

(Derived from Oxford 2001)

Confidence in predictions

It is important to consider the likelihood that a change/activity will occur as predicted and also the degree of confidence in the assessment of the impact on ecological structure and function. The limitations to certainty should be described and the consequences for confidence in predictions must be stated clearly. A qualitative description may be adequate, though an objectively defined scale defined according to a stated convention is probably more helpful, and can be used even if the decision as to confidence level can only be based on expert judgement, rather than frequency data, as long as this limitation is stated. Hence, a scale that is meaningful in normal language might be: Certain, Probable, Unlikely. Alternatively, based on the fact that the 5% confidence level is conventionally chosen as the lowest limit for acceptable statistical significance in common scientific practice, a four-point scale that could be usefully employed is:

- Certain/near-Certain: probability estimated at 95% chance or higher.
- Probable: probability estimated above 50% but below 95%.
- Unlikely: probability estimated above 5% but less than 50%.
- Extremely Unlikely: probability estimated at less than 5%.

The reason for including a confidence level category of 'extremely unlikely' is that some effects may be very improbable, but extremely serious should they occur and hence merit contingency planning. Where doubt exists as to which of two categories of probability best fits the level of professional confidence, the more conservative level should be cited.

In some cases, ongoing survey or monitoring may be required to refine predictions or activate mitigation proposals.

When describing changes/activities and impacts on ecosystem structure and function, reference should be made to the following parameters, which are discussed below:

- positive or negative;
- magnitude;
- extent;
- duration;
- reversibility; and
- timing and frequency.

Positive or negative

Is the impact likely to be positive or negative? Positive impacts merit just as much consideration as negative ones, as international, national and local policies increasingly press for projects to deliver positive biodiversity outcomes.

Magnitude

Magnitude refers to the 'size' or ‘amount’ of an impact, determined on a quantitative basis if possible. For example: a likely increase of three in the number of wombats killed per year on a road; a total loss of the structure and function of semi-natural grassland replaced by tarmac; a partial loss of the structure and function of grassland subject to increased risk of wind-blown biocide. Whilst it may not be possible to provide a quantitative assessment in the latter example, application of some of the following parameters will provide a more accurate understanding of the likely impact.

Extent

The extent of an impact is the area over which the impact occurs. When the receptor being considered is the habitat itself, magnitude and extent may be synonymous.

Duration

The time for which the impact is expected to last prior to recovery or replacement of the resource or feature. This should be defined in relation to ecological characteristics (for example species lifecycles) rather than human timeframes. For example, five years, which might seem short-term in the human context or that of any other long-lived species, would span at least five generations of dragonflies.

The duration of an activity may differ from the duration of the resulting impact caused by the activity. For example, if short-term construction activities cause disturbance to birds during their breeding period, there may be longer-term implications due to a failure to reproduce in the disturbed area during that season.

Reversibility

For the purposes of this guidance, an irreversible (permanent) impact is one from which recovery is not possible within a reasonable timescale or for which there is no reasonable chance of action being taken to reverse it. A reversible (temporary) impact is one from which spontaneous recovery is possible or for which effective mitigation is both possible and an enforceable commitment has been made.

In some instances, the same activity may cause both irreversible and reversible impacts. For example, consider two of the potential impacts arising from the placement of a temporary access through a forest that is subsequently allowed to grow over. The change experienced by common birds of the loss of food and shelter may be reversible, as these resources will be replaced once the access route has grown over. Many birds are sufficiently mobile and adaptable to accommodate this change with no significant impact on populations. But, the impact on ground flora along the route of the access may be irreversible (or effectively so) if fragile woodland soils have been compacted.

Timing and frequency

Some changes may only cause an impact if they happen to coincide with critical life-stages or seasons (for example, a bird nesting season). This may be avoided by careful scheduling of the relevant activities, e.g. by the implementation of an Environmental Management Plan that specifies important constraints in relation to the timing of works.

The frequency of an activity and hence the resulting impact should also be considered. For example, there may be occasions when a single person walking a dog will have very limited effect on nearby waders using wetland habitat. However, if numerous walkers subject the waders to frequent disturbance, then feeding success may be significantly reduced. In extreme cases the birds could be permanently displaced.

Characterisation of the change and impact

In order to characterise the likely change and impact, it is necessary to take into account all the above parameters. An illustration of this is given below:

e.g. The operational phase of a temporary access road through a wood will create an increase in noise. An assemblage of woodland-edge birds, in 5 ha of quality breeding habitat within a distance of 5 km from the road, will experience an increase on average, of 20 decibels of noise for three hours per day for two breeding seasons.

Confidence in describing these changes is high, based on information from the engineers and the noise and traffic assessments. However, the impact on the breeding success of the birds is less certain, as the response of all species to increased noise levels is not fully understood. From reference to published research, it is probable that the assemblage of breeding birds will change in composition, as the more susceptible species within the assemblage will fail to breed in the zone of influence during the operational period, but others will continue to breed and some may be more successful than usual, by taking advantage of the spare resources not employed by the susceptible species. As there is alternative suitable breeding habitat contiguous with the zone of influence, it is likely that the susceptible birds will move back in after the temporary access is removed, although it may be several generations before the assemblage resembles its baseline condition.

Risk and Uncertainty

Risk Assessment

Risk assessment is fundamental to EcIA but the type of risk assessment most commonly used in project EIA has a different purpose. This section describes the relationship between EcIA and the risk assessment process often applied to whole-project EIA, where a matrix may be used, such as the Australian and New Zealand standard for risk assessment (AS/NZS 4360:2004), which multiplies the "likelihood" of an event by its "consequence".

Although whole-project risk matrices can be used to map-out the characteristics of a multi-faceted EIA, they are not a substitute for EcIA.

EcIA is by its nature a risk assessment because the impact consequence can never be proved - it can only be predicted within degrees of confidence.
To establish the "consequence" criterion in an overall EIA risk assessment, the EcIA first needs to be completed so the prediction of likely impacts has a rigorous scientific basis.

For any given likelihood, there is a particular consequence. For example, if noise occurs regularly, then it is very likely and the consequence of effects on a nearby nesting bird may be severe but if noise likelihood is unlikely, then the predicted consequence may be negligible. During the assessment of effects, we have to take the most likely "likelihood" and base the impact assessment on this. For example, a noise specialist may deduce that a particular threshold would be exceeded on average, several times a day, give or take a margin of error. We then predict the subsequent impact, which is also within a range of variation, reflecting degrees of uncertainty as well as real environmental fluctuations. Hence, "consequence" is the embodiment of impact prediction in EcIA. Because "likelihood" is the basis for prediction of "consequence", EcIA is by its nature a risk assessment.

Integrating impact assessment results into a final project risk assessment, combining other environmental, social, economic and cultural factors, needs to be done with great care. By taking the "consequence" from the EcIA and arbitrarily re-multiplying it by additional likelihood criteria, there is a risk of 'double-dipping' and diluting the significance of ecological predictions. These final risk assessments are also sensitive to modification of likelihood and consequence thresholds. Critics might suggest that results can be 'made-to-fit' but in truth, it remains such a crude representation of underlying EcIA, that modifying thresholds would create as many problems as solutions.

Critically, the final risk assessment should be viewed in the context of its objective, that is to crudely map-out project risk characteristics. Risk assessment is most appropriately used to i) systematically review matters and make sure everything of importance has been assessed to a level roughly proportional to project risk; and ii) to combine ecological data with all other data and inform decisions about project alternatives.

Therefore, although risk assessment is a useful decision support tool, it is a parallel process to EcIA and should never be used as a substitute. Whole-project risk assessment, using a crude matrix of likelihood x consequence predictions is not a basis for decision-making as it does not reflect significance. The significance of an asset has nothing to do with likelihood x consequence, it has to do with the most likely range of consequences x the *value* of the loss in socio-economic, cultural and biodiversity terms.

Uncertainty Analysis

Uncertainty is at the heart of risk assessment and EcIA but is not directly equivalent. As discussed above, risk assessment models are not completely reliable so EcIA managers and decision-makers should be aware of some of the characteristics of uncertainty and how they should be presented in EcIA reports.

A key source of uncertainty is lack of information to inform the EcIA process. The early development and inclusive process of EcIA for scoping and determination of value are both integral to reducing this key uncertainty. Other common sources of uncertainty are to do with the inherent variability of the environment. The implementation of appropriate survey and reporting aims to reduce this by taking into account ecological variability. For example, surveys should be done in different seasons or across different habitats and unavoidable sources of sampling bias should be identified.

The manner in which a report author reached their conclusion should be clearly given, wherever possible referenced to independent literature and using conventional terminology. Uncertainty can also derive from the way something is written and it is important that the author makes every effort to explain things clearly and unambiguously. This is helped by applying judgement in relation to predetermined values, as discussed above. These subjective judgements are an unavoidable component of EcIA but need to be evidence-based, so depend on a rigorous EcIA process rather than guess work. Where there is no evidence available, this should be stated so all opinions are wholly omitted from the EcIA report. Note, opinions may form part of the process for an expert witness but this is a separate matter not discussed here.

Quantitative measurement of uncertainty in risk assessment and EcIA may be possible where results depend on a mathematical model. Elsewhere, judgement based on rudimentary ecological theory leads to a range of possible conclusions rather than a single result. Proof is rarely if ever possible and statements such as "there will be no impact" are usually inappropriate. Where the results of an investigation reveal a range of conditions e.g. upper and lower 95% confidence limits, it is best to present the range rather than the mean / average.

Uncertainty is an inherent fact in ecology and should not be used as an excuse to disregard any reasonable evidence or proceed to approval without any monitoring. All available evidence should be considered on merit but whether they are appropriate to the question of ecological impacts depends on whether a robust EcIA process has been followed. Research studies are not normally applicable directly to EcIA, though they may inform the process. Statistical power, based on simple measures e.g. of a species' population, are usually inappropriate surrogates for biodiversity loss. This depends on more holistic assessment of ecological function and process, which is measured in different ways. The result is the sum of all changes in the environment from an ecosystem perspective not any one variable.

Assessment of Whether Impacts are Ecologically Significant

Determining Ecologically Significant Impacts

Legislation and policy guidance often require 'significant' (or an equivalent term) negative or positive impacts to be distinguished from others.

In this guidance an ecologically significant impact is defined as an impact (negative or positive) on the integrity of a defined site or ecosystem and/or the conservation status of habitats, communities, species or critical ecosystem processes within a given geographical area.

The value of any feature that will be significantly affected is then used to identify the geographical scale at which the impact is significant*. This value relates directly to the consequences, in terms of legislation, policy and/or development control at the appropriate level. So, a significant negative impact on a feature of importance at one level would be likely to trigger related planning policies and, if permissible at all, generate the need for development control mechanisms, such as planning conditions or legal obligations, as described in those policies. If such policies do not exist, then the mechanism to address the impacts may be voluntary e.g. based on biodiversity offsets procedures (see here).

**It is important that value is pre-determined (see Determining Value) and used to establish the geographic context of significance. It is inappropriate for a consultant to work backwards, having quantified the impact, to decide whether this is of any particular geographic importance. To do so would undermine the need to determine values independently and undermine the independence of the impact assessment process.*

During the assessment process, it may be found that a site or ecosystem considered likely to be subject to a significant impact and therefore 'scoped in', is, on further investigation, unlikely to suffer a negative impact to its integrity. However, this will not preclude there being features within that site that are themselves of sufficient value to meet the threshold for the assessment and for which there is likely to be a significant effect on their conservation status. For example, whilst a particular impact may not be considered likely to have a negative effect on the integrity of a Ramsar Site, it may be found to be likely to have a significant impact on the conservation status of a population within the Ramsar site (not a qualifying species) that is of local value.

To summarise, if an ecological resource or feature is likely to experience a significant impact, the consequences in terms of development control, policy guidance and legislation will depend on the level at which it is valued. Significant impacts on features of ecological importance should be mitigated (or compensated for) in accordance with guidance derived from policies applied at the scale relevant to the value of the feature or resource. Any significant impacts remaining after mitigation (the residual impacts), together with an assessment of the likelihood of success in the mitigation, are the factors to be considered against legislation, policy and development control in determining the application.

There may be conditions or legal agreements attached to a consent to ensure the delivery of the proposed mitigation. The willingness of the roponent to enter into such arrangements will influence the assessment of the likelihood of success of the mitigation.

Integrity

In order to test whether or not an impact will affect the integrity of a site or ecosystem (and is thereby significant) it is necessary to understand whether the changes arising from the proposed project are likely to move the baseline / existing conditions at the site or ecosystem closer to, or further from, the condition which constitutes 'integrity' for that system. Another way of putting this, is to consider the change against what would be considered benchmark biodiversity. In New South Wales and in accordance with the EIANZ Ecology Final Draft Discussion Paper on Biological Diversity ("Biodiversity") this means:

- That biodiversity is conserved, in situ, across all levels and scales - structure, function and composition are conserved at site, regional, state and national scales;
- that examples of all ecological communities are adequately managed for conservation; and
- that ecological communities are managed to support and enhance viable populations of flora and fauna and ecological functions.

A site/ecosystem that achieves this level of coherence is considered to be at favourable condition.

To help understand this further, the components of ecological integrity of a site/ecosystem may include the following:

- the assemblage of different ecosystem processes, including human influences;
- the dynamics of the ecosystem at different scales; and
- the levels of habitats and/or populations, where the desired condition is the average level that would be considered 'acceptably characteristic of the site or ecosystem'.

In some jurisdictions, there are statutory / policy mechanisms for measuring biodiversity against benchmark habitats. For many sites, neither the favourable nor the baseline condition is described in these or any other terms. The ecologists contributing to the EcIA will therefore have to make their own assessments of what constitutes the baseline and favourable (benchmark) conditions. One way to do this is to follow recommendations made by the Business Biodiversity Offsets Program - see Biodiversity Offsets .

In order to assist ecologists to determine whether there is likely to be an effect on the integrity of a site or ecosystem, the answers to the following questions should be considered:

1. Will any site/ecosystem processes be removed or changed?
2. What will be the effect on the nature, extent, structure and function of component habitats?
3. What will be the effect on the average population size and viability of component species?

This should be in the light of the overall question:

- Will this move the condition of the ecosystem/site towards or away from favourable (benchmark) condition?

It should be noted that it is very unlikely to be possible to evaluate impacts in terms of integrity without considering functions and processes acting outside a site's formal boundary, particularly where a site clearly falls within a wider ecosystem. Thus any predictions should always consider wider ecosystem processes i.e. be evaluated in the context of the regional landscape.

Many ecosystems have a certain 'freeboard' in terms of biophysical change that can be absorbed before the fundamental ability of the site or ecosystem to support characteristic communities or species' populations is compromised. Clearly there will sometimes be an element of doubt as to whether the change is sufficient to cause such changes to condition described above. This should be reflected in confidence levels attached to the prediction. Mitigation measures may then be proposed to increase the level of confidence in that prediction, even when a negative effect on integrity is not predicted.

When assessing potential impacts on sites with international and national designations, integrity should be considered with detailed reference to the published citations and conservation strategies. Many such strategies list conservation objectives with associated 'criteria features', 'attributes', 'measures' and 'targets' against which likely changes can be assessed.

In cases of reasonable doubt, especially in relation to sites of National or International value, a precautionary view should always be taken, and a negative effect on integrity predicted.

For beneficial effects that may result in the creation of new sites or ecosystems, or intervention to restore degraded examples, the concept of integrity is equally applicable in that the intervention must be sufficiently robust as to sustain the new level of value created in all reasonably predictable scenarios.

Conservation Status

It is recommended that the concept of 'conservation status' is used to determine whether an impact on a habitat or species is likely to be ecologically significant. There are likely to be a range of documents available to make this judgement, at an international, national and state level.

Conservation status may be evaluated for any defined study area at any defined level of ecological value. The extent of the area used in the assessment will relate to the geographical level at which the feature is considered important.

In some cases, there may be an existing statement of the conservation status of a feature with formal objectives and targets. Most species or habitats will not be described in this way. In this case, the conservation status of each feature being assessed should be agreed between the ecologists working on the assessment during the scoping process.

When assessing potential effects on conservation status, the same reasoning should be applied as set out above in relation to integrity. The known or likely trends and variations in population size should be considered. The level of ecological resilience likely to exist, in terms of the quality of physical and biotic conditions, that would permit the given population of a species or area of habitat to continue to exist at a given level, or continue to increase along an existing trend, should also be estimated.

A significant positive impact could be defined as one that prevented or slowed and existing decline as much as one that permitted a population or habitat area to increase.

Impact Management - Mitigation

Overview

Mitigation includes any deliberate action taken to alleviate adverse effects, whether by controlling the source of impacts, or the exposure of ecological receptors to them (Treweek, 1999).

Mitigation methods can be categorised into several types (Box 8).

Box 8: Types of ecological impact mitigation

Avoidance

- Sensitive design
- Siting based on least damage criteria
- Avoidance of key areas (e.g. protected or important habitat)
- Avoidance of key periods (e.g. breeding season)
- Desisting from impact-generating actions.

Reduction, moderation, minimisation

- Emission controls
- Noise barriers
- Oil interceptors
- Controlled access during construction / operation
- Wildlife bridges, tunnels, 'ecoducts'
- Wildlife fences

Rescue (relocation, translocation)

- Translocation of plants or animals
- Translocation of habitat

Repair, reinstatement, restoration

- Reinstatement of habitat (woodland, wetland, grassland etc.)
- Re-seeding of grassland
- Restoration of damaged hydrological function (e.g. reinstatement of raised water level areas)

Compensation

- Financial contributions to conservation
- Biodiversity offsets

(Derived from Treweek, 1999)

To meet the demand for net ecological gain rather than simply achieving damage limitation, proponents of any scheme should incorporate, as part of the proposals for scheme design and implementation, measures to facilitate ecological enhancements through offsets. However, as discussed in the section Biodiversity Offsets this may need to be done subsequent to the EcIA process and may not be statutorily required. Nevertheless, it is a growing demand for which there are statutory requirements in some jurisdictions and is increasingly necessary to address macro-environmental problems associated with biodiversity loss, such as loss of water resources, soil erosion, impacts on nature- or landscape-based tourism and carbon sequestration.

There is a limit to how much biodiversity loss can be realistically offset if objectives of 'non net loss' or 'net gain' are to be achieved either now or in the future. The process has to be scientifically and financially realistic i.e. what is lost cannot be so valuable as to forbid its replacement within a reasonable time-scale elsewhere. Therefore, before any decision is made to approve the loss of biodiversity, everything should be done to avoid and minimise impacts. In Box 8 (above), this means mitigation measures under the first four main headings. Impacts should be avoided, especially those that could be significant. Significant loss can be defined as a loss that is irreversible or affects a biodiversity component that is vulnerable to extinction. The geographic scale of significance varies (see Determining Ecologically Significant Impact). For example, a local vegetation community may be considered highly endangered and therefore irreplaceable, either at a strategic or a site-specific level. Once everything has been done to avoid impacts, everything should then be done to minimise or reduce negative impacts that cannot be avoided. Only then can workable offsets actually be achieved.

Wherever possible, mitigation measures should be developed and incorporated into a project as part of the design process, as measures that are fully integrated into a project have a greater guarantee of delivery. The objective should always be to agree the identified measures with the proponent of a project so that they become part of the scheme that is subject to detailed assessment (e.g. as part of an Environmental Management Plan, or its equivalent). A shopping list of 'proposed mitigation' at the end of an EcIA is of very little value as it requires the responsible authority to enter into discussion with the proponent to agree what will be implemented. An EcIA is effectively meaningless if it provides an assessment of the significance of the residual impacts of a scheme based on the proposed mitigation measures being implemented even though these measures have not been agreed by the developer or their efficacy tested in the EcIA process.

Priority should be given to the avoidance of impacts at source, whether through the re-design of a project or by regulating the timing or location of activities. If it is not possible to avoid significant negative impacts, opportunities should be sought to reduce the impacts, ideally to the point that they are no longer significant or, where absolutely necessary, biodiversity loss can be offset.

Offsets are designed to meet specific ecological objectives that will deliver meaningful and equivalent replacement for the negative impacts that are predicted. This is not the same as on site enhancement or rehabilitation (see Box 8). These are part of mitigation measures but are unlikely to secure an increase in biodiversity value due to the small size and fragmented nature of remnants. Similarly, compensation, although a potentially source of funding for offsets, will not create biodiversity gain if it is research-based rather than practical. Compensation is not recommended unless there is a measurable and deliverable biodiversity gain to be had.

More information on the creation of offsets can be found in the section Biodiversity Offsets. As discussed there, the creation of offsets may be done as part of the EcIA process or subsequent to approval. In some parts of Australasia there are statutory mechanisms for offsets and in other parts, its implementation may be voluntary. With or without legislation, there is a strong business case for biodiversity offsets, which by their nature, address important socio-economic and cultural needs.

Due to the uncertainty associated with the success of proposed mitigation measures, evidence should be provided of the effectiveness of recommended mitigation and to what extent their success can be guaranteed e.g. a review of technical limitations, the timescale over which predicted benefits are to be realised and the level of commitment in terms of resources, including variations through adaptive management. If possible, information from similar projects should be used to support statements about the level of success that can be reasonably expected.

Mitigation should be presented in terms of the integrity or conservation status of the resources or features to which it applies. For example, mitigation may be designed to ensure that the status of a species' habitat can be maintained following development.

Monitoring and Management

In EcIA, monitoring is specifically used to inform management actions, by measuring change in habitat condition. Monitoring for any other purpose is simply surveillance and is not relevant to EcIA.

If mitigation/compensation measures are part of planning conditions or obligations, the proponent has a requirement to implement them fully. These conditions or obligations may require the implementation of a monitoring program as a basis for remedial measures. It is good practice to monitor the success of mitigation measures and to remedy the situation should any of the implemented measures fail e.g. due to lack of management or uncertainty in the precise outcome. It is important to clearly and explicitly define objectives. An Environmental Management Plan (or its equivalent) can be a useful means of drawing together mitigation, management and monitoring proposals. Joint agreement of plans by proponents and consultees can strengthen their implementation. Such a plan may be enforced by legal agreement.

Follow-up and monitoring is more likely to take place if it is built into legal agreements or planning conditions. Ideally, measurable objectives, which set the trigger thresholds and targets for management action, should be agreed by all of the ecologists involved in the EcIA process.

Monitoring metrics should use the same principles for biodiversity assessment in EcIA and not necessarily be limited to protected species . Although it may be helpful to monitor populations, individual species are rarely an appropriate surrogate for biodiversity. Even a species' population may not be the best measure of its own ecological requirements. Care should be taken to ensure that the chosen range of monitoring metrics are ecosystem-relevant. These will most likely relate to the most important matters identified in the project scoping. Monitoring variables would indicate change in ecological structure and function, as well as the abundance and behaviour of species.

If monitoring incorporates the creation of biodiversity offsets, a balance sheet showing gains and losses may be used to indicate the value of the contribution.

Adaptive Management and Continual Improvement

Due to inherent uncertainty in EcIA, predictions about the extent of biodiversity loss, the ability to minimise loss and the outcomes of biodiversity offsets can never be perfectly guaranteed. The objective of EcIA should be to create a measurable outcome (either minimise loss or compensate through offsets). Monitoring and management can help but the precise nature of the resulting habitat is unknown so there has to be a framework for adapting to unforseen ecological constraints and continuously improving the outcome.

For example, fluctuations in rainfall may alter soil humidity resulting in a different vegetation community than expected around the edges of a wetland. Where there is the expectation that vegetation can be replaced "like for like" this is almost never achievable, which is why replacement of high quality intact vegetation is particularly unrealistic. The community of species that eventually occupy the replaced / enhanced habitat will also be different so care needs to be taken to ensure that mitigation objectives are not overly optimistic with respect to threatened species. This is particularly in terms of minimum viable patch size and connectivity with the surrounding landscape.

To maximise biodiversity value, management will focus on the structure and function of habitat. Simply monitoring species does not necessarily achieve this. The aim is to actively create a mosaic of different overlapping habitat niches so the diversity and abundance of species increases. Monitoring should be a combination of physical habitat variables, as well as a full range of species, threatened or otherwise, that are indicative of structure and function. Management needs to be on the ground and might include selective planting, mowing, thinning, burning or grazing.

Adaptive management therefore, means maximising outcomes within the constraints that the environment imposes. Although there may be legal obligations associated with this, it is not constructive to bind proponents of development to a particular outcome when there is doubt this may be achieved. Conditions should be flexible enough to acknowledge natural variation but robust enough to control the level of effort, so impacts are mitigated to the greatest extent practicable. If this can be done by creating measurable biodiversity offsets this is best, as it provides an auditable account of the proponent's achievements. A measurable no net loss / net gain solution would provide proponents with the best guarantee of compliance.

Identifying Residual Impacts

It is often helpful to set out in an EcIA report how a project has evolved in response to ecological considerations and to indicate how mitigation that has been incorporated into the scheme design has avoided / minimised ecological impacts. This is especially important where is any uncertainty about the efficacy of mitigation measures. The resulting assessment is the assessment of "residual impacts". The identification of significant residual impacts follows the same process as the identification of impacts. Note, if the purpose is to proceed to biodiversity offsets, other residual impacts may be relevant and not just those deemed "significant".

Where mitigation is fully integrated into the scheme and there is high confidence that it will be implemented and will deliver the desired outcomes, it may be appropriate to skip straight to the assessment of significance of residual impacts of the mitigated project.

The residuals are impacts that remain once everything has been done to avoid and minimise significant biodiversity loss. Note, offsets and compensation are not part of mitigation. The assessment of residual impacts (and their value) is what determines the extent of offset and / or compensation that is required. The assessment of residual impacts is always the final step in the process of impact assessment.

Impact Management - No Net Loss / Net Gain

Biodiversity Offsets

Overview

Biodiversity Offsets are measurable conservation outcomes resulting from actions designed to compensate for residual adverse biodiversity impacts arising from project development and persisting after appropriate prevention and mitigation measures have been implemented. In some jurisdictions, there are existing statutory mechanisms for creating offsets and the relevant metrics for measuring biodiversity loss / gain already exist. Where these do not exist, a suitable alternative method will shortly be available from the Business Biodiversity Offsets Program (BBOP).

The goal of offsets is to achieve no net loss, or preferably a net gain, of biodiversity. In order to demonstrate no net loss of biodiversity, offset developers must be able to define and measure the residual impact on biodiversity lost at the impact site and the amount of biodiversity gained from the offset.

The steps in creating offsets are outlined in Box 9. Although the process may appear arduous, with foresight the majority can be done as part of the steps outlined in the EcIA process above. The BBOP method uses a Habitat Hectares approach, derived from the model used in Victoria (Australia) and similar to the process used in New South Wales, so some developers will already be doing this as part of development approval processes in the region. Elsewhere, the methods can be adapted to suit. Note however, the viability of offsets still depends on the quality of the foundation EcIA, particularly the need to avoid and minimise impacts on site, so the principles and procedures outlined earlier should be rigorously implemented.

Box 9: Steps in the creation of offsets

Quantify losses with respect to key habitats at the impact site

- Identify a benchmark site
- Select and weight the benchmark attributes and record the reference level of each
- Quantify the pre-project condition of the attributes at the impact site
- Predict the post-project condition for each attribute
- Calculate the predicted biodiversity loss at the impact site

Where necessary, quantity losses with respect to key species at the impact site

- Identify species that require a species-specific quantification of losses
- Select and appropriate metric for each species
- Identify a benchmark population for each species
- Assess likelihood of persistence of the benchmark population
- Assess likelihood of persistence of the impact site population (pre-project)
- Calculate losses with respect to the species at the impact site

Develop a shortlist of potential offset sites

- Determine whether the offset is a candidate for an out-of-kind offset
- Identify potential offset sites

Select appropriate offset sites and calculate offset gains

-

- Screen sites on the basis of the biodiversity components they support
- Screen sites on the basis of their potential to demonstrate additionality
- Quantify and map pre-intervention condition classes at each shortlist offset site
- Assess the threats facing each potential offset site
- Identify interventions to address threats facing each site
- Calculate biodiversity gained at each shortlist offset site (for habitats, and, if necessary, for species populations)
- Screen sites on the basis of their sufficiency to support key biodiversity components into the long term
- Classify candidate offset sites on the basis of their conservation priority
- Prioritize candidate offset sites within each level on the basis of additional criteria
- Review landscape-level planning opportunities and constraints
- Consider socio-economic gains possible at each candidate offset site
- Assess whether biodiversity multipliers are required and calculate area ratio required

Define the activities for the biodiversity offset and their location

- Review the outputs generated in the selection of sites and calculation of offsets
- Develop an overall objective for the offset
- Further define the offsetting activities to be undertaken
- Detail a specific location and rationale for each activity, and consider what will be required to successfully implement the offset

(Derived from BBOP)

As it is outside the scope of this document to reiterate the BBOP documentation, only an outline is provided. For more detail, refer directly to the BBOP Toolkit, available online at http://www.bbopconsultation.org/.

Principles of Biodiversity Offset

The following principles for biodiversity offset were agreed by the Advisory Committee of the Business Biodiversity Offsets Program (2009). It is notable that most of these principles are the same as those recommended for EcIA, hence the process of addressing offsets can be done fairly readily within the EcIA framework.

- **No net loss:** A biodiversity offset should be designed and implemented to achieve in situ,measurable conservation outcomes that can reasonably be expected to result in no net loss and preferably a net gain of biodiversity.
- **Additional conservation outcomes:** A biodiversity offset should achieve conservation outcomes above and beyond results that would have occurred if the offset had not taken place. Offset design and implementation should avoid displacing activities harmful to biodiversity to other locations.
- **Adherence to the mitigation hierarchy:** A biodiversity offset is a commitment to compensate for significant residual adverse impacts on biodiversity identified after appropriate avoidance, minimization and on-site rehabilitation measures have been taken according to the mitigation hierarchy.
- **Limits to what can be offset:** There are situations where residual impacts cannot be fully compensated for by a biodiversity offset because of the irreplaceability or vulnerability of the biodiversity affected.
- **Landscape Context:** A biodiversity offset should be designed and implemented in a landscape context to achieve the expected measurable conservation outcomes taking into account available information on the full range of biological, social and cultural values of biodiversity and supporting an ecosystem approach.
- **Stakeholder participation:** In areas affected by the project and by the biodiversity offset, the effective participation of stakeholders should be ensured in decision-making about biodiversity offsets, including their evaluation, selection, design, implementation and monitoring.
- **Equity:** A biodiversity offset should be designed and implemented in an equitable manner, which means the sharing among stakeholders of the rights and responsibilities, risks and rewards associated with a project and offset in a fair and balanced way, respecting legal and customary arrangements. Special

consideration should be given to respecting both internationally and nationally recognized rights of indigenous peoples and local communities.

- **Long-term outcomes:** The design and implementation of a biodiversity offset should be based on an adaptive management approach, incorporating monitoring and evaluation, with the objective of securing outcomes that last at least as long as the project's impacts and preferably in perpetuity.
- **Transparency:** The design and implementation of a biodiversity offset, and communication of its results to the public, should be undertaken in a transparent and timely manner.
- **Science and traditional knowledge:** The design and implementation of a biodiversity offset should be a documented process informed by sound science, including an appropriate consideration of traditional knowledge.

The Role of EcIA in Planning of Biodiversity Offsets

Impact assessment incorporates well established procedures for collecting and interpreting information on biodiversity and ecosystem services, and can be used to provide a "before and after" picture of the distribution, status and condition of biodiversity affected by a proposed plan or project (Box 10). When integrated with environmental management systems and plans, impact assessment offers a potential delivery mechanism for offsets and a basis for ongoing monitoring and adaptive management. Early consideration of possible requirements for biodiversity offsets and their integration with impact assessment can help to avoid duplication of effort in the collection of data.

Biodiversity offsets can make an important contribution to the conservation and sustainable use of biodiversity. Impact assessments can be strengthened as a tool for sustainable development by incorporation of the concept of "no net loss" or "net gain" to help deliver a more outcome-oriented approach.

Box 10: How impact assessment can contribute to the design and implementation of biodiversity offsets

- providing a structured approach to the collection of information on biodiversity
- quantifying potential losses of biodiversity associated with a proposal
- providing information needed to determine whether 'no net loss' of biodiversity can be achieved
- interpreting the significance of impacts on biodiversity/ biodiversity losses
- identifying biodiversity impacts which require mitigation, and residual adverse impacts remaining after mitigation which could be offset
- generating information on biodiversity distribution and status which is needed to interpret impact significance for different geographical contexts
- generating contextual information on biodiversity distribution and status which is needed for planning the design of offsets and for the selection of suitable offset locations
- providing a standardized and widely used approach

(Derived from BBOP)

The extent to which planning for offsets should be fully incorporated as an integral part of the EIA process may vary as it can potentially overload the EcIA process. The aim of EcIA is to demonstrate that impacts on biodiversity have been reduced to an acceptable level, such that development consent can be given to a proposal. In cases where a significant residual adverse impact on biodiversity will remain following implementation of proposed mitigation, the planning of the offset could be pursued as part of the EcIA or accounted for separately e.g. as a requirement of the project EMP.

Offsets integrated within EcIA

Effective integration requires an iterative approach in which the potential use of offsets is considered at an early stage (during scoping or sooner). The resource requirements for offsets need to be considered during the scoping phase, such as the availability of land, skills to expedite an offset plan and any financial or time constraints that may be needed in addition to the EcIA process. The study area also needs to be confirmed, based on a review of proposed activities (see Scoping) but baseline studies may need extending to include appropriate benchmark sites - sites that are used as a measure of 'good condition, providing a set of measurable set of objectives that offset sites are managed towards. The following table outlines the integration of offset planning within EcIA.

Stage in planning of development	**Stage in assessment**	**Information required for offset planning**
During business case development / pre-feasibility	Strategic review (through SEA or existing national data)	Gain understanding of: • Biodiversity risks and opportunities • Biodiversity policy and goals • Background trends in threats and rate of loss of biodiversity associated with this type of activity e.g. level of cumulative impact • Key partners and capacity • Potential role of offsets and availability of implementation frameworks, e.g. to meet policy goals
During inception phase for project (see scoping)	Possible baseline assessment or preliminary risk assessment	• Review location-specific risks and opportunities • Identify stakeholders who should be involved and the level of involvement
Project development / design (see determining value)	EcIA and Social / Cultural Impact Assessment	• Presence of biodiversity triggers for EcIA may also suggest possible need for offsets (risks to valued biodiversity)
Project Feasibility or design	EcIA scoping	• Possibility of offsets informs scope. • Stakeholder engagement is a key component for offset planning. • Consider possible needs for finances to support offsets as well as possible need for land procurement and negotiations with land-owners.
Detailed design	Impact assessment	• Impact assessment process quantifies losses
Detailed design	Identification of mitigation measures	• Include identification of need for offsets in cases where residual adverse effects remain after mitigation hierarchy is followed. • Plan offsets to achieve "no net loss". • Possible gains through offsets need to be quantified to demonstrate this.
Project development / construction	EMP implementation and / or follow-up	• Implement offsets and monitor their success / effectiveness. • A balance sheet showing losses and gains may need to be produced to that the contribution made by the offset is clear.

The main advantages of having offset design fully integrated with EcIA are:

- EcIA can provide a rationale for the offset by identifying and quantifying impacts on biodiversity.
- Through application of the mitigation hierarchy, EcIA demonstrates which impacts can be avoided and which can"t, in order to identify unavoidable significant adverse residual impacts for which an offset might be appropriate.
- EcIA provides the information needed to calculate losses and gains in biodiversity in order to determine how "no net loss" can be achieved through an offset.
- Through the Environmental Statement, EIA can provide a documented biodiversity "loss/gain account" to demonstrate how offsets have been calculated
- Using EIA to collect the information needed to design and implement offsets keeps costs down.
- Decision-makers can evaluate reliably the net outcome of the development taking into account planned mitigation and offsets, and include offset conditions as part of the consent for development.
- The implementation of offsets in practice may well require land purchase or complex management agreements with landowners or communities. Integrating offset design with the EIA process may help to identify possible budget requirements early. This only applies if sufficient time is allocated to the EcIA process however.

References

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Glossary

Avoidance See mitigation.
Baseline conditions The conditions that would pertain in the absence of the proposed project at the time that the project would be constructed/operated/decommissioned. The definition of these baseline conditions should be informed by changes arising from other causes (e.g. other consented developments).
Existing conditions see baseline conditions

Benchmark The measure of 'good' or 'excellent' habitat condition for a given vegetation type or species' habitat. Benchmarks are used as the baseline measure of condition, against which other similar habitat condition is gauged.

Biodiversity The biological diversity of the earth's living resources. The total range of variability among systems and organisms at the following levels of organisation: bioregional, landscape, ecosystem, habitat, communities, species, populations, individuals, genes and the structural and functional relationships within and between these different levels. Note, biodiversity is not the same as species richness, though species richness may be one of many measures of biodiversity value.

Compensation Measures taken to make up for the loss of, or permanent damage to, biological resources through the provision of replacement areas. Any replacement area should be similar to or, with appropriate management, have the ability to reproduce the ecological functions and conditions of those biological resources that have been lost or damaged.

Responsible authority An organisation or individual who is responsible for determining an application for a consent for a project.

Connectivity A measure of the functional availability of the habitats needed for a particular species to move through a given area. Examples include the flight lines used by bats to travel between roosts and foraging areas or the corridors of appropriate habitat needed by some slow colonising species if they are to spread.

Ecological Effects are what happens to an ecological component when there is any alteration of the physical, biological or chemical status quo. This might be a behavioural change, such as a birds taking flight near a main road; animal mortality resulting from direct habitat loss; or a change in vegetation community structure due to alteration of hydrology. This is distinctly different from an Ecological Impact. Note, impacts and effects may be used interchangeable where one "impact" causes an effect, that imposes an impact on another resource. For example, the effect of an impact on a wetland, causing a significant reduction in waterbird numbers, might be to have an impact on tourism.

Ecological Impacts are the consequence of an Ecological Effect occurring. For example, if behavioural disturbance results in increased mortality, the impact would be the level of that effect in terms of population viability. Ecological Impacts might also be measured in terms of the local, regional or national percentage of a particular vegetation type that is removed or otherwise affected.

Ecosystem Services are the values that humans get from the environment. They are based on processes that support human health and welfare including the support and regulation of critical ecosystem processes e.g. carbon cycles and water quality; the provision of food and tourism; and cultural and spiritual well being.

Environmental Management Plan (EMP) In this document EMP has been used to denote any document in which the management of environmental issues is detailed.

Environmental Impact Assessment (EIA) is used to describe any assessment generally required to address the environmental impacts (including ecological impacts) of a project, as part of a statutory approval process.

Enhancement A new benefit to biodiversity, unrelated to any negative impact.

Fragility The degree of sensitivity of habitats, communities and species to environmental change. It requires a consideration of intrinsic and extrinsic factors.

Fragmentation The breaking up of a habitat, ecosystem or land-use type into smaller parcels.

Habitat A place in which a particular plant or animal lives. Often used in the wider sense referring to major assemblages of plants and animals found together.

Integrity The coherence of a site's ecological structure and function across its whole area that enables it to sustain the habitat, complex of habitats and/or levels of populations of the species for which it was classified.

Mitigation Measures taken to avoid or reduce negative impacts. Measures may include: locating the development and its working areas and access routes away from areas of high ecological interest, fencing off sensitive areas during the construction period, or timing works to avoid sensitive periods. An example of a reduction measure is a reed bed silt trap that is designed to minimise the amount of polluted water running directly into an ecologically important watercourse. See also compensation (which is separate from mitigation).

Niche The 'space' or 'ecological role' occupied by a species and the resources used by a species. Conceptually the niche is multidimensional and each resource (food, time of feeding, etc.) and each abiotic factor (salinity, temperature, etc.) can be considered to be a dimension of the niche.

Net gain The point at which the quality and quantity of habitats or species improves compared to their original condition. i.e. improvements over and above those required for mitigation/compensation.

No net loss The point at which habitat or biodiversity losses equal their gains, both quantitatively and qualitatively.

Population A collection of individuals (plants or animals), all of the same species and in a defined geographical area.

Project In this document 'project' is used to refer to any development proposal(s)/scheme or other land use change for which it may be appropriate to undertake an EcIA.

Rarity A measure of relative abundance.

Receptor Any ecological or other defined feature (e.g. human beings) that is sensitive to or has the potential to be affected by an impact.

Reduction See mitigation.

Residual Effects are synonymous with Ecological Effects but are the remaining level of effect once mitigation measures have been put in place.

Residual Impacts are synonymous with Ecological Impacts but are the remaining level of impact once mitigation measures have been put in place.

Resource Any ecological or other environmental component affected by an impact.

Restoration The re-establishment of a damaged or degraded system or habitat to a close approximation of its pre-degraded condition.

Scale The level or geographic context for evaluation.

Scoping Determination of the extent of an assessment (of an EcIA or full EIA).

Species Richness The number of different species in an area. Note, this different to biodiversity.

Zone of influence The areas/resources that may be affected by the biophysical changes caused by activities