OIL AND GAS ECOLOGICAL ASSESSMENT FOR TASMAN BAY, GOLDEN BAY AND THE MARLBOROUGH SOUNDS

Report

Produced for Friends of Nelson Haven and Tasman Bay Inc. and
AWE New Zealand Pty Limited

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Simon Mustoe is Director of AES Applied Ecology Solutions PL and a professional ecological consultant with over 12 years experience practising in Australia, New Zealand, southern Africa, Hong Kong, the US and UK. He convenes the Environment Institute of Australia and New Zealand's (EIANZ) Ecology Group and is principal editor of the draft: "*Ecological Impact Assessment: Towards the Development of Guidelines for Australia and New Zealand*" (EIANZ, 2009). He is also coordinating the development of certification standards for ecologists in Australia and is a Certified Environmental Practitioner himself.

Since starting AES in 2002, Simon has completed over 100 contracts in a broad range of terrestrial and marine environments on behalf of a public, private and NGO sector clients. He has acted as a peer-reviewer and expert witness in numerous planning hearings and inquiries and provided evidence in a criminal conviction case on whale harassment. He has a strong working knowledge of the theory and principles of environmental legislation and ecology in practice, including surveys, assessment and offset management. He has particular expertise in the design, implementation and presentation of ecology in Environmental Impact Assessment (EIA) and in the independent peer review of such studies. He is also an author of two recent books on survey standards including *Bird Census Techniques* (Academic Press, 2000) and chapters of the *Handbook of Biodiversity Methods* (Cambridge University Press, 2005).

Simon's personal specialisation and interest is in marine fauna, including whales and dolphins, turtles, seabirds and generally, in marine and terrestrial ornithology. He sits on the inaugural committee setting up the Marine Mammal Observer Association and has considerable personal experience in offshore survey of marine fauna and EIA for the oil and has industry, particularly during seismic exploration. He has worked on commercial development projects in New Zealand associated with Maui's Dolphin and undertaken offshore survey work with Sperm Whales, Dusky Dolphin and seabirds. He has a detailed knowledge of the ecology of Southern Ocean seabirds and marine mammals. In Australia, he helped draft the strategic environmental assessment on offshore oil and gas exploration for the Department of Industry and most recently, was commissioned by WWF Australia to lead the monitoring and reporting of effects of the Montara Oil Leak, which is currently under a Commission Inquiry.

EXECUTIVE SUMMARY

0.1 Statutory tools for managing coastal biodiversity in New Zealand include, amongst others, the Resource Management Act 1991 ("RMA") and the New Zealand Coastal Policy Statement 1994 ("NZCPS")[1]. The purpose of the RMA and in turn the NZCPS, is to promote the sustainable management of natural and physical resources by managing the use, development and protection of natural and physical resources in a way, or at a rate, which safeguards the life-supporting capacity of air, water, soil, and ecosystems and avoids, remedies or mitigates any adverse effects of activities on the environment. One of the mechanisms for achieving this statutory purpose is the requirement that applications for resource consents include an "Assessment of Environmental Effects" (AEE).This is a type of environmental impact assessment ("EIA"). Ecological impact assessments ("EcIA") are a component of EIAs.

0.2 New Zealand is committed to the Convention on Biological Diversity (CBD) and New Zealand's obligations pursuant to the CBD are reflected in the provisions of the RMA. There are numerous international authorities and approaches to practising ecology when undertaking an EcIA which, are designed to realise the intention of the CBD and are recognised by the CBD as appropriate methods of protecting and maintaining biodiversity. In short, the RMA and its associated policy statements support the adoption of international standards of best practice for ecological impact assessments ("EcIA") and in turn, EcIA is a way to achieve the purpose and principles of the RMA in New Zealand.

0.3 This document identifies where these best practice processes fit within the statutory planning process in New Zealand. Many of the principles of ecology which apply when carrying out an AEE are contained within the regulatory framework that guide decision-making, including the *New Zealand Coastal Policy Statement 1994, the New Zealand Biodiversity Strategy* and relevant Regional and District Plans. The *Treaty of Waitangi*, is also applicable. However, it is also recognised that the "ability to sustainably manage activities in the coastal environment is hindered by the lack of understanding about coastal processes", so there is need to take a precautionary approach and seek additional knowledge, to guide decision-making.

0.4 Hence, establishing not just what impacts are but whether "adverse effects" can be avoided, mitigated or remedied, appears to be one of the most important components of the AEE process. In order to prepare a AEE therefore, adequate evidence and knowledge needs to be gathered to appropriately address this question.

[1] The Proposed New Zealand Coastal Policy Statement 2008 was notified in March 2008 and is intended to replace the 1994 NZCPS. Public submissions have been received but the Proposed NZCPS has not yet been approved.

0.5 Adequate ecological assessment is an essential part of achieving sustainable management and the purpose of the RMA, so a robust framework for AEEs is essential. Although the process is relatively straightforward, it is fraught with problems if it is not done rigorously, systematically and credibly. A framework for AEEs is presented, in accordance with the Environment Institute of Australia and New Zealand's (EIANZ) working draft Ecological Impact Assessment: Towards the Development of Guidelines for Australia and New Zealand, which in turn reflects the principles of the International Association for Impact Assessment (IAIA) and numerous other authorities.

0.6 The stage of predicting impacts is part of any assessment of impacts or effects, including an AEE. It is always a relatively small part of the process. More importantly, in order to assess environmental effects there is a need to adequately scope the project to decide what needs detailed investigation. This depends on identifying the range of relevant ecosystem services (supporting, regulating, provisioning and cultural), working closely with other studies to ensure compatibility of data, scoping and undertaking fieldwork and identifying / agreeing what is valuable and the limits of acceptable change. The consequence of any potential impact is therefore measured against these findings, allowing authorities to make an informed and objective judgement about whether consent should be granted to a particular application.

0.7 Field investigation is a critical part of EcIA. There cannot be any certainty about likely impacts and effects or how to manage them, unless there is reasonable spatial and temporal understanding of ecology. Although species may themselves be protected, the main focus is on ecosystems and ecological processes. Care should be taken to ensure that data is collected at a relevant spatial scale and provides output at a resolution that fits use as a decision-support tool.

0.8 There are numerous examples of the use of seabird mapping as part of offshore environmental assessments. Seabirds are the only group that is numerous, species rich (but not too species rich), highly conspicuous, relatively easy to identify (compared to all other animal groups), are found everywhere and have very well researched biology and ecology. They are the only group of organisms that can be used for rapid biodiversity assessment, in a reasonably short time-scale and provide data on an ecosystem level.

0.9 It has been recommended that seabird studies at least, should help understand the ecological processes in the regional environment, providing publicly consumable evidence about areas of high, medium and low importance for biodiversity. Mapped spatially, these data provide a way of making important design decisions, in accordance with the requirement to avoid, remedy, and mitigate adverse effects under the RMA. This baseline knowledge can help target additional focused work, e.g. on given species or particular habitat locations.

0.10 Case studies are shown in this report, which indicate that costs, in terms of finance and time for undertaking ecological studies, are not unreasonable. However, additional investigations may always be necessary, if scoping surveys identify new constraints. Nevertheless, adequate early scoping is designed to minimise this risk. The use of certified practitioners with relevant experience and adequate public engagement during scoping also further minimise costly omissions and delays in the process.

1. INTRODUCTION

The Friends of Nelson Haven and Tasman Bay Inc. commissioned Simon Mustoe of AES Applied Ecology Solutions Pty Ltd to develop a framework for the implementation of best practice in ecological assessment for offshore oil and gas exploration and development in the Tasman Bay, Golden Bay and the Marlborough Sounds coastal marine area[2].

1.1 REPORT OVERVIEW

The coastal and marine areas of New Zealand have not been well described. According to Government of New Zealand, (2000) "current knowledge of marine life and how marine ecosystems work is not adequate to show whether we are sustainably managing New Zealand's marine biodiversity" and that "the management of the coastal and marine environment and of impacts on that environment needs to be integrated within an ecosystem-based framework with explicit biodiversity objectives." The need to gather information to inform the assessment of effects on the environment is implicit in New Zealand's legislation for sustainable management[3]. A key mechanism in this process is Environmental Impact Assessment (EIA).

EIA is the collective term for all environmental assessments. In New Zealand, the *Resource Management Act 1991* requires that an "Assessment of Environmental Effects" be carried out as part of an application for resource consents. An AEE is a form of EIA. Where this report discusses EIA processes, this is in the context of an AEE.

The International Association for Impact Assessment (IAIA) (IAIA, 1999) and the United Nations (United Nations, 2005) have agreed three over-arching principles of environmental impact assessment (EIA), needed to maintain the integrity of any assessment process:

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[2] The Coastal Marine Area (CMA) means the foreshore, seabed, and the coastal waters, and the air space above the water, between the outer limits of the territorial sea (the 12 nautical mile limit) and either one kilometre upriver, or to a point upstream that is calculated by multiplying the width of the river mouth by five (whichever is less).

[3] Sustainable management is defined in section 5 of the RMA.

Rigorous - the process should apply 'best practicable' science, employing methodologies and techniques appropriate to address the problems being investigated.

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.

Credible - the process should be done with professionalism, rigor, fairness, objectivity, impartiality and balance and be subject to independent checks and verification.

Ecological impact assessment (EcIA) (sometimes referred to as biodiversity assessment) is the component of EIA that relates to ecosystems, species, habitats and biodiversity. It has its own scientific best practice principles, methods and techniques. These ensure that information is collected in the right way: that it can be integrated with other studies (e.g. engineering and socio-economic) so that it forms a functional part of the EIA process. In short, it is designed to promote a necessary level of "rigour" and ensure that the work is done "systematically" and therefore addresses the IAIA principles.

The principle of "credibility" is critical but depends more on regulation of individuals undertaking the work and is therefore not considered in detail in this report. It suffices to recommend that those engaged in EIA should be able to demonstrate objectivity, impartiality and independence. This could, for example, be as members of a professional association e.g. the Environment Institute of Australia and New Zealand (EIANZ)[4] or as a Certified Environmental Practitioner (CEnvP), who can demonstrate a *professional qualification* and knowledge relevant to the subject of an assessment – in this case, biodiversity in the context of EcIA for the offshore and coastal environment.

Justification for a standard EcIA approach can be found in the definition of "sustainable management" in the *Resource Management Act 1991.* This is discussed in section 2 of this report. Note however, this report is not concerned with the legal case. It takes a scientific approach and discusses the relevance of best practice to the RMA's purpose.

The key references to EcIA best practice used in this report are all professionally peer-reviewed and designed to be used *in practice*. The Environment Institute of Australia and New Zealand (EIANZ) is shortly to launch a working draft of *Ecological Impact Assessment: Towards the Development of EcIA Guidelines for Australia and New Zealand.* This document includes standards published by a range of organisations including the International Association for Impact Assessment (IAIA), the UK's Institute of Ecology and Environmental Management (IEEM) and the Business Biodiversity Offsets Program (BBOP). The document sets out:

[4] http://www.eianz.org/membershipinfo/eianz-code-of-ethics

- the steps in an EcIA process, required to maintain the integrity of the process, and as a foundation for biodiversity outcomes;
- it provides a reference on how best to implement specific biodiversity tools (such as those imposed / recommended by responsible authorities); and
- in the absence of an existing statutory method, it recommends ways of to augment the process, so it can still achieve outcomes.

It also identifies internationally-accepted "basic", "guiding" and "operational" principles for EcIA and has been used as a reference for developing the assessment framework in this report (Table 4).

Finally, rigorous implementation of EcIA depends on collection of field information using objective methodologies. Standard at-sea methods of biodiversity survey would be sufficient for most offshore projects to understand areas of high and low sensitivity to impacts, to quantify risk and develop mitigation measures. Recommended methods suitable for overall assessment under an AEE are provided as case studies in section 4. In some projects, assets of great value, under threat, may warrant additional investigation but this is outside the scope of this project. In these instances, reference should be made to established literature on the design of specific research studies for ecological assessment (e.g. Hill et al., 2005; Treweek, 1999).

1.2 BIODIVERSITY VALUE OF TASMAN BAY, GOLDEN BAY AND THE MARLBOROUGH SOUNDS

The area is contained within the South Cook Strait Coastal Biogeographic region (Ministry of Fisheries and Department of Conservation, 2008). Being recognised as a distinct biogeographic area means it has characteristics that are unique, compared to other parts of New Zealand (

Table 1).

Approximately 0.32% of the bioregion is protected in five marine reserves, making it second to Fiordland (1.01%) in terms of marine protected areas for New Zealand (Ministry for the Environment, 2008). The marine reserves are: Sugar Loaf Island, Long Island – Kokomohua, Tonga Island, Horoirangi Marine Reserve and Westhaven (Te Tai Tapu). Nevertheless, according to government policy "New Zealand's marine reserves cover only a tiny area of New Zealand's marine environment and are not representative of the range of distinctive coastal and marine habitats and ecosystems" (Government of New Zealand, 2000).

Table 1: South Cook Coastal Biogeographic Region information (Ministry of Fisheries and Department of Conservation, 2008).

Biogeographic Region	Boundary	Description
South Cook Strait Coastal Biogeographic region	Kahurangi Point on the west coast Strait and the Marlborough Sounds to Cape Campbell on the east coast of South Island	This region lies in a transition area between northern and southern flora and faunas although the tidal regimes each side of the strait are different and the water temperature is also very different. Cold water upwelling occurs off Farewell Spit in the region from Kahurangi Point. The current influences around Kahurangi Point result in a change in species assemblages. Includes Golden and Tasman bays, Clifford Bay and the Marlborough Sounds, D'Urville Island. Areas of special interest include: high tidal flows areas of Cook Strait and Sounds, Kahurangi Shoals.

Some information on the ecosystems of the Marlborough Sounds region are detailed in the Marlborough Sounds Resource Management Plan (Marlborough District Council, 2003), based on Davidson et al., (1995). However, these are not comprehensive with regard to the region's marine ecology. For example, they provide no information on areas of importance beyond the immediate coastline, even though jurisdiction extends to 12 Nm offshore. There are only two areas of ecological value cited in the plan that extend to any degree into coastal waters (Table 2).

Table 2: Marine ecosystems of the Marlborough Sounds region (Marlborough District Council, 2003)

Marine Ecosystems	Description of Marine Ecosystem	Areas of Ecological Value	Description of areas of Ecological Value
B. D'Urville Island – Northern Cook Strait	**Ecosystem Character** Exposed; clear, cool oceanic waters; strong currents; off-shore reefs, stacks and islands; rich reef communities; bryozoan and horse mussel beds; massive tube worm colonies. Exposed shores are distinguished by their steeply sloping shores with extensive bedrock and boulder reefs extending into relatively deep water. Clear oceanic waters with relatively low sedimentation levels. Relatively cool oceanic waters, particularly east of D'Urville Island. High current areas off headlands and between land masses. Moderate to high tidal range. **Form/Geology** The area is generally noted for the presence of numerous off-shore reefs, stacks and islands. Gravels and sands predominate off-shore of western D'Urville Island. Large sand masses occur off-shore in the larger outer bays, but mud/silt/shell remains the predominant soft bottom habitat elsewhere. A relatively narrow cobble (and in	D'Urville Island, North-west Coast	High level of natural character. Low turbidity, high diversity of macroalgae. High scenic/seascape values - rocky reefs, sea cliffs, coastal scrub.

	places bedrock) reef generally fringes the shores of the sheltered bays and inlets. **Biological Environment** Near-shore and off-shore reefs support rich and abundant reef communities. Luxuriant stands of macro-algae extend into relatively deep water but some exposed water varieties (e.g.; Durvillea spp, Lessonia variegata) are noticeably absent. High diversity of fish and invertebrate species. The occurrence of large off-shore areas dominated by bryozoan corals and horse mussels are distinctive features of the area. The more sheltered bays and inlets support fewer conspicuous reef dwelling species and considerably less macro-algae cover. Coastal wetlands at heads of major bays and inlets.		
D. Tasman Bay / Admiralty Bay	**Ecosystem Character** Turbid, warm waters; open to the sea, but relatively sheltered; limited reef zone and conspicuous marine life generally sparse; sediments off-shore. Moderate sedimentation and turbidity levels. Relatively warm coastal waters derived from the D'Urville current and Tasman Bay. Large tidal range exposing a wide inter-tidal zone at low water. Very strong currents in the vicinity of French Pass, though low to moderate elsewhere. **Form/Geology** Relatively narrow near-shore bedrock/cobble reef zone, with sand beaches often located at the heads of bays. Extensive areas of sand/shell in places close to shore, replaced by silts in deeper off-shore areas. **Biological Environment** Notable for a low biomass and diversity of macro-algae which are restricted to a narrow band immediately below low water. Sub-tidal reefs relatively barren, though there is often a high diversity of fish and encrusting animals in outer rocky areas compared to other sheltered shores in the Sounds. Key indicator organisms are the barnacle Balanus vestitus east of French Pass, and Stegnaster inflatus which is particularly common in the west. Whangarae Estuary within Croisilles Harbour is relatively unmodified and the only spit formed estuary in the Sounds.	1/04 French Pass, D'Urville Island	Example of fast flow habitat (best in Marlborough) supporting community of filter-feeders. Mussels, anemones and barnacles. Bottlenose dolphin regular visitors. Unmodified natural environment. Best example of submerged ridge in Sounds.

In addition to those described in Table 2, there are a wide variety of seabirds that breed within the area (including King Shag *Phalacrocorax carunculatus*, the only endemic species in Marlborough Sounds) and feed in adjacent coastal and offshore waters. They are both a conspicuous and important component of ecosystem processes including food chain energy regulation, nutrient processing and dispersal.

It is beyond the scope of this document to detail further ecosystem values of the region, as this is part of the process of developing an EIA, either at the strategic or project-specific level.

2. Ecological Impact Assessment in the RMA

2.1 Introduction

The purpose of the *Resource Management Act 1991* (RMA) (s5) is to promote the sustainable management of natural and physical resources (excluding minerals). Use of terms such as "adverse effect" are consistent with the Convention on Biological Diversity (CBD)[5] and therefore, reflect New Zealand's obligations to it (Otago Regional Council, 2006).

EcIA has a vital part to play in implementing the principles of the Rio Declaration on Environment and Development [subsequently known as the Convention on Biological Diversity] (Treweek, 1999).

The CBD is the main international platform for applying assessment techniques to biodiversity (Brooke, 1998). The CBD has its own draft guidelines on biodiversity-inclusive EIA, "*according to the internationally-accepted sequence of procedural steps characterizing good practice EIA (e.g. IAIA's principles of EIA best practice*" (United Nations, 2005).

The following sections examine the context of the RMA's wording in terms of the ecological component of EIA – namely Ecological Impact Assessment EcIA).

2.2 RMA and Sustainable Management

In subsection 5(2) of the RMA, "sustainable management" is defined as:

> managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic, and cultural well-being and for their health and safety while—
>
> a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
>
> b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
>
> c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

These requirements are also read in conjunction with clause 2 of Schedule 4 of the RMA which lists "Matters that should be considered when preparing an assessment of effects on the environment". These include:

(a) any effect on those in the neighbourhood and, where relevant, the wider community including any socio-economic and cultural effects;

[5] United Nations (1992) Convention on Biological Diversity, 17 June 1992. United Nations, New York.

(b) any physical effect on the locality, including any landscape and visual effects;

(c) any effect on ecosystems, including effects on plants or animals and any physical disturbance of habitats in the vicinity;

(d) any effect on natural and physical resources having aesthetic, recreational, scientific, historical, spiritual, or cultural, or other special value for present or future generations;

(e) any discharge of contaminants into the environment, including any unreasonable emission of noise and options for the treatment and disposal of contaminants; and

(f) any risk to the neighbourhood, the wider community, or the environment through natural hazards or the use of hazardous substances or hazardous installations.

From an ecological assessment perspective, there are three particularly relevant components. These are explained in the following sections.

2.3 LIFE-SUPPORTING CAPACITY OF ECOSYSTEMS

Subsection 5(2)(b) of the RMA places emphasis on life-supporting capacity of ecosystems.

"…changing human conditions drive, both directly and indirectly, changes in biodiversity, changes in ecosystems, and ultimately changes in the services ecosystems provide. Thus biodiversity and human well-being are inextricably linked" (Millennium Ecosystem Assessment, 2005).

The RMA supports the assessment of impacts measured in the context of what is commonly termed "Ecosystem Services". Ecosystem services are the direct or indirect benefits that human populations obtain from ecosystems (Table 3).

As shown in Figure 1, Supporting Ecosystem Services are a function of ecological processes such as nutrient cycling, soil integrity and primary production. None of these are possible without "habitat" and its conservation is needed if the benefits of ecosystem services are to be sustained (McAlpine et al., 2007). Safeguarding life supporting capacity, in ecological terms, would mean maintaining a minimum level of habitat integrity.

Since habitats cannot exist unless their constituent species e.g. seabirds, kelp, seagrass and even micro-benthos are protected, it is not the "environment", "habitat" or even "species" that are the focus of an AEE but the relationship between all these things: the "ecology".

There is also dependence on ecosystems for direct provisioning, such as fisheries and uncontaminated water. These tend to be more readily identified and measured than supporting and regulating services (but are no more important). Finally, cultural importance is significant. This is not just an intangible aesthetic measure but a practical part of co-existence with the environment. For example, the Maori cultural concept of *wai ora* is for clean and water, with obvious health connotations.

Hence, the value of ecosystems in terms of life support function needs to be measured in ecological impact assessment (EcIA) under the RMA, and is founded in the science of ecology.

Table 3: Categories of ecosystem service (adapted from Millennium Ecosystem Assessment, 2005).

Type	Description
Supporting	Ecosystem services that are necessary for the production of all other ecosystem services. Some examples include biomass production, production of atmospheric oxygen, soil formation and retention, nutrient cycling, water cycling, and provisioning of habitat.
Regulating	The benefits obtained from the regulation of ecosystem processes, including, for example, the regulation of climate, water, and some human diseases.
Provisioning	The products obtained from ecosystems, including, for example, genetic resources, food and fiber, and fresh water.
Cultural	The non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values.

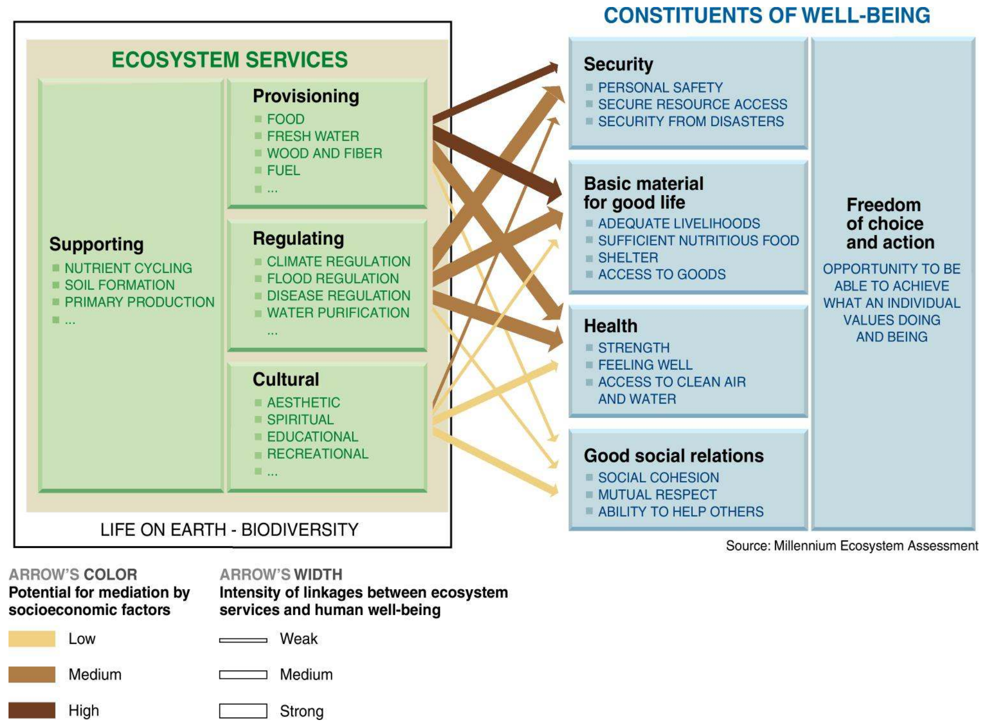


Figure 1: Ecosystem services and their relationship to human well-being (Millennium Ecosystem Assessment, 2005).

2.4 ADVERSE EFFECTS

2.4.1 Definitions of effect and the role of likelihood in project screening

The first stage of any environmental assessment process is project screening. Screening means "to determine whether or not a proposal should be subject to EcIA and, if so, at what level of detail" (EIANZ, 2009; IAIA, 2005). It is assumed that activities using the assessment framework in this report would already be subject to an AEE, which means screening has already taken place. Nevertheless, the scope of matters to be included in the AEE need to be determined.

Section 3 of the RMA defines what is meant by "effect", indicating that even activities that have low probability but high potential consequence should be included in an AEE.

With limited exception, an effect is:

(a) any positive or adverse effect; and

(b) any temporary or permanent effect; and

(c) any past, present, or future effect; and

(d) any cumulative effect which arises over time or in combination with other effects—regardless of the scale, intensity, duration, or frequency of the effect, and also includes—

(e) any potential effect of high probability; and

(f) any potential effect of low probability which has a high potential impact.

The RMA clearly recognises the need to address all effects, including those that may be low probability but have potentially serious impacts or consequences. Probability and consequence are two axes on a standard risk assessment matrix, such as the Australian/New Zealand Risk Management Standard (AS/NZS 4360:2004). The scope of an environmental assessment usually needs to be set early, using broad expert opinion, rather than any scientific investigation. Research by the Australian Centre of Excellence for Risk Assessment (ACERA) shows over-whelming evidence that opinion-based estimates of probability over-estimate confidence (Burgman, 2008). Hence, caution is advised when interpreting initial predictions of likelihood, as there may be little substantiating evidence.

Hence the assessment process is designed to investigate matters for which there could possibly be a serious impact (even if the likelihood is low) and to ask whether this is likely to be an "adverse effect".

2.4.2 Defining an "adverse effect"

Central to any ecological assessment is consideration of the "significance" of a potential impact or effect (Table 4). In practical terms, this would appear to be synonymous with the expression "adverse effects" in subsection 5(2)(c) of the RMA. Even though it seeks to deal with *any* adverse effects, related subsections imply that there is in fact a threshold of significance. So the acceptability of a project will depend on the particular circumstances of the application and the characteristics of a wide range of effects. So the question about what is an "adverse effect" is why AEEs are necessary.

There is a generally accepted principle that effects are quantified in terms of both their context and intensity. In jurisdictions such as Australia (DEWHA, 2005) and the United States (NEPA, 40 CFR 1508.27), this is translated into law. The justification makes common and scientific sense and there is a useful metaphor by Barrister Chris McGrath that explains how:

The use of the "context or intensity" of an impact in determining its significance can be most simply understood by using examples of injuries to human health. An injury involving the loss of a person's leg (intensity) would clearly be considered to have a significant impact on that person's health. In contrast, catching a cold or flu would not normally be considered a significant impact on a person's health. However, if the person is 90 years of age and already in poor health (context), catching a cold or flu may well be significant as it can potentially lead to pneumonia and death. Both context and intensity therefore need to be considered to decide whether there is a significant impact (McGrath, 2004).

Evaluating significance, or in this case the context for the adverse effect will depend on the merits of each situation. As discussed above, ecosystem services need to be taken into account. Section 6 of the RMA also specifies certain cultural and natural resource considerations, stating that persons exercising functions and powers under the RMA shall recognise and provide for the following matters of national importance:

(a) the preservation of the natural character of the coastal environment (including the coastal marine area), wetlands, and lakes and rivers and their margins;

(b) the protection of outstanding natural features and landscapes;

(c) the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna;

(d) the maintenance and enhancement of public access to and along the coastal marine area, lakes, and rivers;

(e) the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga;

(f) the protection of historic heritage; and

(g) the protection of recognised customary activities.

Additional information regarding the context for assessing effects on biodiversity (which includes ecosystem processes and natural resources) would also be found in the New Zealand Biodiversity Strategy (http://www.biodiversity.govt.nz/).

The *New Zealand Coastal Policy Statement 1994* also details the national priorities, giving additional guidance to decision–makers about what is considered relevant to the scope of "adverse effects".

2.4.3 Marlborough Sounds Resource Management Plan

The relevant regional council is tasked with making decisions in respect of consent applications for activities in the coastal marine area. Each Council has a regional plan which reflects the requirements of the RMA. The Marlborough Sounds Resource Management Plan (the "Plan") applies in the Marlborough Region. Section 9.2.1 contains a series of objectives and policies that reflect the RMA's requirements, including the need to "avoid, remedy and mitigate the adverse effects of use and development of resources in the coastal marine area", though this only applies within the outer limits of the territorial sea: 12 Nm from the coast.

The Plan (section 9.3) recognises that:

Rigid controls are necessary in the coastal marine area as this is the 'environmental sink' where the effects of all coastal and land-based activities impact. Coastal marine ecosystems depend on uncontaminated seawater, undisturbed seabed or foreshore and healthy land and freshwater ecosystems adjacent to the coast.

The Plan sets out a wide range of objectives and policies, which include for example, (policy 1.1 in section 9.3.2):

Avoid the discharge of contaminants into the coastal marine area where it will modify, damage or destroy any significant ecological value; areas identified by iwi as being of special spiritual, cultural or historical significance; and areas identified as outstanding landscape.

To realise these objectives, for example when assessing applications for discretionary activities, the Plan states:

The assessment criteria for Discretionary Activities involving foreshore and seabed alterations, enable the effect of the alteration on the coastal marine area to be assessed. An assessment of the effect of the proposed alteration on Maori, cultural and heritage values, natural character, landscape and ecological values will also be required.

2.5 AVOID, REMEDY OR MITIGATE

The purpose of the RMA is achieved, inter alia, by "avoiding, remedying, or mitigating any adverse effects of activities on the environment" (section 5(2)(c)). Hence, if adverse effects are likely, the RMA may still permit activities to go ahead, provided the effects can be appropriately avoided, remedied or mitigated.

Whether this is possible depends on the level of adverse effect but also whether mitigation is likely to work. These are dual considerations. If an application is to achieve this and the RMA purpose, establishing whether adverse effects can be avoided, mitigated or remedied, would appear to be one of the most important aspects of any AEE and depends on having gathered adequate evidence and knowledge. This is consistent with the precautionary approach, as detailed in the New Zealand Coastal Policy Statement (Policy 3.3.1) and the principles of the Treaty of Waitangi, where Taonga includes all valued resources and intangible cultural assets, including "fishing grounds, harbours, foreshores (as well as the estuary and the sea, together with the use and enjoyment of the flora and fauna adjacent to it)" (Hayward, 1997).

The way one achieves these objectives is by applying principles of avoiding and minimising impacts (which includes mitigation and remediation), as internationally accepted and detailed by the Convention on Biological Diversity (Article 14):

> *Each Contracting Part, as far as possible and as appropriate shall:*
>
> *(a) Introduce appropriate procedures requiring environmental impact assessment of its proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimising such effects and, where appropriate, allow for public participation in such procedures.*

"Impacts should be avoided, especially those that could be significant… 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" (EIANZ, 2009).

Generally, avoidance is done in one of two ways: by not approving a project, or by design alterations. Design alterations may include using different technology, doing work at different times of year or in a different location. Assessment of alternatives is a fundamental principle of environmental assessment (Raff, 1997). Any one particular pre-conceived approach may not be the best option and could be unacceptable. The assessment process is best used to identify the most sustainable and acceptable course of action, rather than to justify a preconceived design, when there is the risk this may not be acceptable.

3. ECOLOGICAL ASSESSMENT FRAMEWORK

Ecological impact assessment is a relatively straightforward process but subject to considerable problems if it is not done systematically. Project scoping is the most important part of any environmental assessment as it helps define the assessment and agrees methods of implementation and analysis. Properly done, it is a very efficient way to establish projects, as it offsets public relations problems early and ensures that the assessment is focused on the right assets.

The impact assessment step, which happens after this, is a relatively minor component. It reconciles the knowledge of existing conditions, the characteristics of the project and the values and ecology of the receiving environment. Information regarding all of the above is identified, prioritised and collected in the scoping stage.

3.1 PROJECT SCOPING

The first step in an assessment process is to decide what adverse effects are relevant. In the case of the RMA, it would be necessary to determine which consequences of an activity are likely to give rise to "adverse effects".

Where there is reasonable evidence that an adverse effect *could* occur, this matter should be carried forward for detailed investigation (see section 2.4). At the same time, risks that would appear to be within the realms of speculation should be "scoped out" of the assessment, streamlining and focusing the assessment on the most important issues. The best outcome is if the community and the responsible authority can reach some agreement on the final scope of the assessment.

Another critical step is to determine thresholds against-which the significance of any predicted changes will be measured. The objective is to determine which of the effects are "adverse". The RMA provides some indication about the scope of matters that should be considered (see also section 2.4.2 of this report). For some ecological assets, there may be policy guidance on acceptable levels i.e. an adverse effect may relate to critically endangered protected species, nature reserves and World Heritage Areas. For other assets, socio-economic and ecosystem life-support values may be relevant. Close collaboration between different experts and appropriate levels of public consultation at the scoping stage is needed as the values vary from place to place and local knowledge is likely to be a substantial source of evidence. It is extremely important that this process is done a-priori[6].

Both at the screening and scoping stage, the level of effect should use the principle of deduction described in section 2.4.2, considering both the context and intensity of likely impacts. Where at all possible, direct and indirect evidence should be cited to support any conclusions drawn.

Table 4: Framework for ecological assessment

	SCOPING	
A	Obtain information about the project from the proponent or their engineers / designers. Identify project activities likely to cause ecological damage, stress or disturbance.	i) Review information about their spatial extent, timing, frequency and duration ii) Ensure engineers, designers and other environmental consultants gather information in a manner that can be considered in terms of spatial extent, timing, frequency and duration;
B	Concurrently, identify opportunities for delivering biodiversity objectives (e.g. to avoid, mitigate or remediate any adverse effects).	i) Throughout the scoping period, consider potential 'show stoppers' and discuss options for designing these out of the project. ii) Consider any further ways of minimising impacts.
C	Establish a consultation strategy.	i) Identify stakeholders, consultees and all ecologists who should be involved
D	Produce an initial scoping report.	i) Do further consultation with the competent authority, statutory consultees and others involved in the consultation strategy; ii) Refine the scope of the assessment based on feedback on the scoping report and throughout the scoping process.

[6] Failing to predetermine significance thresholds is a serious undermining of environmental assessment process. The core objective of an AEE is to determine what is an "adverse effect". Just because change (including loss or removal of something) occurs, does not necessarily mean it is an "adverse effect". Adverse effects are changes that have an unacceptable consequence for something of value. Hence, before one even begins an assessment, the values and thresholds of acceptability need to be identified and the AEE designed to measure if these thresholds are likely to be exceeded. If the AEE determines that a change will impinge on an important value, then the next question is, should this be avoided or mitigated? Avoidance would be prudent in cases where something is so valuable that the risk of proceeding is too great. In cases where the receiving environment is less valuable (and maybe remediation is possible), then mitigation may be an option. So, by leaving the question of what is valuable to the end of the assessment process, it will rarely be possible to gauge the acceptability of something or how it needs to be managed.

E	Develop an understanding of the ecological context.	i) Review existing data, literature searches, site visits and any baseline studies already carried out. ii) Determine the 'value' of ecological features, based on ecosystem function and services, statutory protection and other relevant information and policies. iii) Determine a threshold for selecting ecological features to be included in the assessment, based on their value. iv) Consider potential sources of cumulative effects.
F	Consider the final scope of the assessment as terms of reference for the AEE.	i) Identify those ecological resources reaching the threshold value which could be affected by the project. ii) Through consultation with the competent authority, agree the likely thresholds of acceptable change associated with potential impacts from the project.
G	Prepare what field work needs to be done	i) Identify the factors affecting the integrity of the relevant ecosystems and the conservation status of relevant habitats and species. ii) Identify ecological features likely to be significantly affected and therefore requiring further study and explain the selection criteria used. iii) Agree details of proposed survey / research methodologies and confirm the study area (including areas of offsite effect). iv) Confirm the criteria that will be used to assess its nature conservation value (which establishes the objectives for the field work). v) Allow for enough survey time to take seasonal features into account
	EXISTING CONDITIONS REPORT	
H.	Produce existing conditions report and append this to the initial scoping (the latter may need to be revised continuously to reflect new findings).	i) Detail the fieldwork findings; ii) Detail new information about the spatial extent, timing, frequency and duration of any effects arising from the project; iii) Detail the statutory requirements of the project and how these have been addressed. iv) Detail the selection process for identifying relevant matters. v) Detail methods used and objectives. vi) Detail criteria used to assess nature conservation value.
	IMPACT ASSESSMENT	
I	Describe how ecological structure and function is likely to change from the baseline.	i) Do this in terms of the magnitude, extent, reversibility, duration and frequency of change. ii) Present a measure of confidence in your predictions about the level of change, efficacy of mitigation measures, and a level of uncertainty associated with any predictions.
J	Describe the ecological impacts that are likely to arise from any change.	
K.	Describe measures proposed to avoid / mitigate impacts.	
L.	Identify likely residual impacts (those that remain post-mitigation and management).	
M	Determine whether any impacts are likely to be ecologically significant.	i) Use pre-determined values including statutory protection, conservation status etc., identified during the scoping period ii) Scope out any impacts that can be avoided / minimised i.e. those that it can be shown are very unlikely to be considered "adverse effects". iii) Identify any other impacts that may need managing.
N	Particularly identify the significance of any residual impacts.	i) Present the final impacts as residual impacts, to be used as the basis of a decision regarding the acceptability of a project.
	FINAL REPORT	

O	Produce final impact assessment report	i) Amend the existing conditions report to reflect any new information obtained ii) Present evidence for the sensitivity of ecological assets to change in the environment, based on literature review. iii) Detail findings concerning the magnitude, extent, reversibility, duration and frequency of change. iv) Detail findings regarding the significance of impacts that were carried forward during scoping. v) Detail the residual impacts and explain their significance. vi) Develop a management plan for the lifetime of the project, which details mitigation of any impacts that could, without management, become "adverse effects", including those for which there is residual uncertainty. vii) Propose monitoring measures to be objective and measurable, and relate to measuring outcomes for the type of management action that may need to be taken (there is no point in monitoring for its own sake).
	ENVIRONMENTAL MANAGEMENT	
O	Manage and monitor any residual risks throughout the project's life.	i) Undertake independent expert monitoring that is suitably objective ii) Report the success / failure of any monitoring measures.

It is important to note that, whilst the stages of EcIA can be set out linearly, iteration of fieldwork and scoping can (and usually does) happen during the process. This is for the simple reason that until field investigations and other environmental and socio-economic studies are done, there is usually little or no relevant and detailed knowledge about an area.

Iteration of the EcIA process may happen, for example, when:

a. visits to a site for fieldwork reveals another constraint, previously unidentified;

b. other environmental studies (e.g. water quality or noise) reveal potential environmental effects much greater than previously determined, which increases the potential significance of impacts on a protected matter previously 'scoped out' of the process;

c. socio-economic studies identify links between a non-protected matter and a community, which requires field work and assessment not previously identified on pure biodiversity grounds;

d. the residual uncertainty about impacts is too great and more work is required to yield greater certainty - this may be to rule out a significant impact or to improve confidence in ability to manage the effects.

Iteration becomes necessary to identify the full range of relevant issues, as described in the following sections, relating to the role of the RMA as an environmental assessment framework. This is why ample time needs to be given to field work and other investigations.

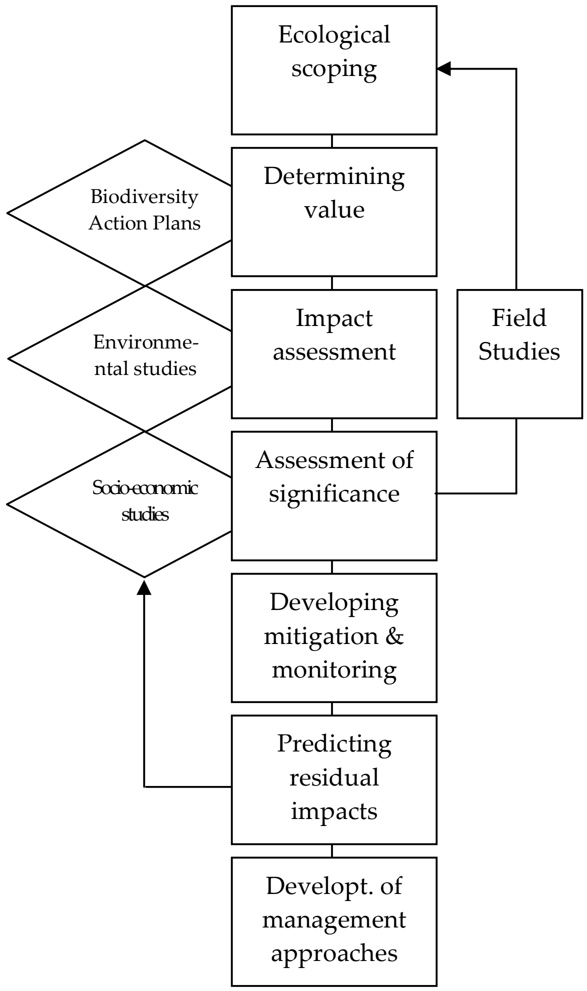


Figure 2: Diagram of EcIA process, showing the iterative relationship between scoping, impact assessment and field studies. It also shows the relationship between the process and other components of environmental assessment.

4. FIELD SURVEY METHODS

4.1 INTRODUCTION

The need for detailed individual studies on particular species or habitats cannot be ruled out of any project, where the assessment reveals an intensive threat to a particularly vulnerable and valuable asset. It is outside the scope of this report to describe how such studies should be developed and users are referred to other relevant literature on survey design (e.g. Hill et al., 2005; Treweek, 1999).

In most cases however, the full range of potential matters should be considered at the outset with a generic survey of relevant areas (see section 4.2). Often, this is sufficient evidence for the assessment process, without significant additional studies.

The objective is to produce mappable information that identifies places that support significant concentrations of birds and other animals. The objective is not to focus on a given species but use communities of species and knowledge of their ecology, to understand underlying ecosystem processes. For example, a large biomass and species-rich location will have high habitat value, indicative of many coinciding processes and a high level of nutrient turnover. The drivers for such locations can be ocean currents, bathymetric features creating upwelling, coastal geomorphology, seabed habitat (e.g. kelp and seagrass) and proximity to breeding colonies.

This initial work may also inform where to do other more costly environmental sampling, such as benthic mapping using Remote / Automated Operated Vehicles and divers. These studies tend to be very labour intensive, costly and have limited geographic coverage. This prohibits sampling large areas in great detail. A key focus of surveys for environmental assessment is to identify areas of *null* importance. This is a critical objective when it comes to managing potential impacts e.g. developing oil spill contingency plans. In the absence of comprehensive spatial coverage, effort will be focused only in areas of highest value. This can bias the impression of habitat importance but more importantly, does not indicate where the areas of least importance are – the areas where human activity are likely to have least impact.

Survey locations placed randomly or, for example, the use of focal-species-studies like satellite tracking, result in holes in GIS layers. Ultimately, surveys for environmental assessment are descriptive so it is better to cover areas evenly, using systematic sampling design, using a line transect approach.

There are two principle rules about ecological surveys that need to be followed, to ensure data integrity. The first is that surveys should encompass seasonality. Generally speaking, there will be at least two very distinct seasons and the difference between these is likely to be stark. Seabirds such as Sooty Shearwaters that nest in summer arrive in their millions. Such birds provide a great deal of information on spatial dynamics and are almost totally absent in winter. Further, weather conditions vary in summer and winter and this affects the likely impacts of activities. For example, oil spill modelling will reveal very different impact areas due to seasonally changing wind direction and strength.

The other rule is the need to replicate surveys. It is always recommended to do a minimum of two samples for any given location (Bibby et al., 2000). This was done in all the case studies in section 4.4. The approach ensures at least some measure of variation in distribution and abundance. Normal protocol would be to undertake two seasons of survey work prior to completion of an ecological assessment.

4.2 Determining the Scope of Surveys

Methods of field investigation for environmental assessment need to be appropriately scaled and located. This depends on having some understanding of the likely temporal and spatial nature of likely effects. In the case of oil and gas development, this might include oil spill trajectory maps, noise transmission models, tanker routes etc. It is important that surveys encompass *all areas* where there is reasonably likely to be an effect *and some distance* beyond this. For example, oil spill trajectory modelling may conclude the most likely direction is north but the wind may still blow south and this needs to be factored in as a "likely" area for an oil spill. Surveying beyond the location places the impact area in some context, with the surrounding seas.

4.3 Marine Fauna at Sea Methods: Overview

There are well-practised standard methods of surveying marine fauna at sea (e.g. Webb et al., 1992). Boat-based surveys are highly recommended over aerial surveys. The latter tend to be used for large-area population studies but are largely unsuitable for biodiversity assessment. When designing a survey, one should ask questions such as (Bibby et al., 2000):

- What scale of precision is required?
- Which and how many species need to be included?
- Do any other variables need to be measured?

Aerial surveys are undertaken at great speed, many of the species of concern (e.g. seabirds) are too small to detect from a plane and there is little chance to record other biodiversity variables, which may relate to nutrient zones, areas of high seabed productivity etc.

Boat-based surveys offer the educated-observer a significant amount more data on "biodiversity". This means the structure, function and composition of the environment, including its species, habitats and ecological processes. This is the "ecology" that is required to address the purpose of the RMA. Merely counting animals does not meet the study's objectives. It is the ecology of the communities of animals observed that is used in the assessment of impacts.

4.3.1 Line Transects

Line transects are highly suited to marine surveys. Detailed methods and software for undertaking and analysing these data are available (Buckland et al., 1993; Thomas et al., 2009).

The principle limiting factor for such data is detection probability, which needs to be controlled for. For example, you cannot compare the number of seabirds seen in one area in a Beaufort Force 5 with another area in Beaufort Force 1. However, observers can generally detect significant numbers of animals and, so long as sea state is controlled for in the data collection by avoiding heavy weather and recording sea state at all other times, this can be factored into the analysis and the effect removed.

Line transect data collection using Distance Sampling methods (Buckland et al., 1993) follows the principle that detection probability declines with distance. Following a standardised observation protocol and measuring the distance to every object sighted, this decline can be modelled and adjusted for animals that are missed. By measuring and adjusting for key confounding variables such as sea state, reliable and comparative estimates of density for different locations can be gathered[7].

If collected systematically, numbers can be extracted by area, providing numerical comparison between locations and mapped with contours in a GIS, for comparison with other ecological variables and the project's impacts.

4.3.2 Relevance of Seabirds for Offshore EcIA

Because it is the ecology and not presence / absence of an animal that is relevant to assessment, we are concerned with animals that are interacting with the water surface, especially when there is evidence that they are feeding. Birds in flight, for example, are recorded separately.

Diving animals such as penguins, seals and cetaceans are only visible at the surface for a proportion of the time, which also affects comparison of data in different areas. In deep water, we might expect fewer encounters with animals that are diving longer, hence a reduced encounter rate. This is why overall seabird data tends to be more reliable.

Seabirds are generally more numerous but there are also more species, so the number of permutations of community composition is large. On spatial scales of tens or hundreds of kilometres, we can understand ocean processes better than if we were to study far less numerous (e.g. whales and dolphins) or far more numerous (e.g. fish and plankton) species.

As discussed above, scale of precision is an important prerequisite for designing ecological surveys for impact assessment. For broad-scale biodiversity assessment for offshore EcIA, seabird data is fit for purpose and cost-effective to collect.

4.3.3 Key Objectives

- To survey each sample (e.g. transect line) at least twice for any given location and over two seasons;
- To map the relative density of biomass, species and groups;
- To quantify the relative abundance and importance of areas within and outside areas likely to be affected by the activity;
- To identify areas of least importance, where activities could go ahead with minimal impact and risk;
- To overlay biodiversity maps with other available information on physical, chemical and biological drivers (e.g. bathymetry, seagrass and kelp beds, substrate-type etc);
- To use the data as the basis for quantitative risk assessment and interpret it in relation to evaluation criteria developed during scoping studies.

[7] Note, due to some inherent systematic biases e.g. the fact that there is an unknown ratio of birds at sea / on nests; or an unknown ratio of breeders to non-breeders, these estimates of density tend to be minimum densities, not absolute. For these reasons, even striving to collect accurate absolute numbers of birds is a panacea. Minimum density is a reasonable basis for spatial risk analysis and a precautionary approach for EcIA. This is because numerical change is an effect but does not equate to degree of *impact*. Impacts can only be measured on a relative scale e.g. comparing magnitude, frequency and duration of change to existing conditions.

- To identify any areas of particularly high biodiversity value.

Box 1: Case Study: HYPOTHETICAL Designing and implementing a survey at sea.

Delineating the survey area

Produce a map, underlay information on bathymetry and overlay the coastline.

Based on all available knowledge about the location likely to be affected, map the outer boundary (red line) and add approximately 40% of additional area to the outer edge (orange line) (a). This is the total survey area.

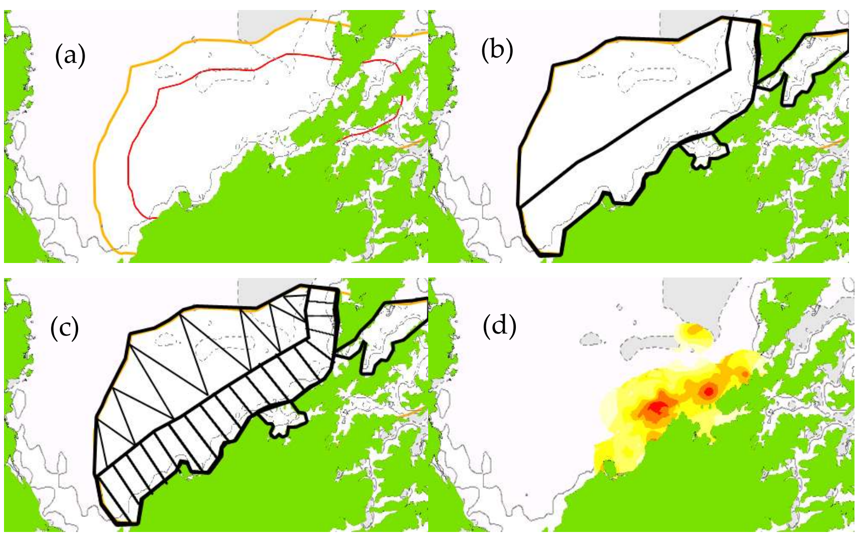
Developing a sampling design

The objective is to develop a series of sample lines that provide complete coverage whilst running across features (to reduce sampling bias) and can be done within reasonable time and budget constraints.

Eyeball the bathymetry and coastal map data within the orange area. Delineate polygons which are likely to have similar characteristics and are reasonably rectangular, to facilitate creation of survey lines (b).

Using a random starting point, generate a systematic survey design – examples given in figure (c). This could be a zigzag sampling protocol (though this can introduce sampling bias in the corners), parallel lines or a grid of lines. It is important that these lines are oriented to cross features. Software Distance 5.0 can be used to generate the design.

HYPOTHETICAL **maps indicating how a survey may be designed for assessment of offshore biodiversity values**



Give consideration to the amount of time required to cover the area, the budget for a vessel, the speed and weather down time. Consider how to balance these constraints with the need to get spatial coverage at a reasonable resolution. Coverage needs to be reasonably even to render informative maps of distribution.

Spatial coverage resolution is important when it comes to mapping. If the resolution is too high, it not only costs more to conduct the survey but can result in too much small-scale variation in data, which is difficult to interpret. Conversely, if the resolution is too small, interpolation of data between lines e.g. for contour maps (d) will not be prone to errors caused by artefacts in the contouring process.

The principle objective is to be able to inform decision-making, so the data has to be high enough resolution to enable management action over scales of perhaps a few kilometres e.g. routing vessel movements, mobilising oil spill equipment etc.

Conducting the Survey

Surveys should be done only in reasonable conditions, which usually means Beaufort force three and below. Methodology should closely follow Webb et al (1992).

The amount of survey effort needed to map seabird distribution does not need to be excessive as the objective is only to understand spatial distribution and abundance for risk assessment. Although the above example is purely hypothetical, it is based on an area of about 2,000km^2. The Port of Melbourne Channel Deepening Project surveys (see Case study, section 4.4.4) covered a similar area with a total line length of 1,000km (540Nm).

If we assume a budget of 500 nautical miles of survey line, a vessel speed of 8 knots and just over 12 hours of observation per day, this distance can be covered in five days. Even with 30% poor weather down time (Beaufort force 4 and above), each survey could be done in about a week – a total of 28 days over two years for baseline biodiversity surveys.

4.4 Case Studies

There are numerous case studies for baseline biodiversity assessment of marine fauna, prior to commercial development in the offshore environment, including oil and gas exploration and production.

4.4.1 Atlantic Frontier, North West of Scotland

The Seabirds at Sea Team of the UK Joint Nature Conservation Committee (JNCC) undertook seabird and cetacean surveys during the 16th and 17th round of UK oil licensing between 1994 and 1997. A condition of licensing was that information be presented by the licensee on the importance of the area for seabirds and marine mammals prior to exploration in the licence blocks. This was to fulfill Environmental Impact Assessment obligations and guide development of oil spill contingency plans.

Individual companies directly funded surveys from 1997 to early 1998 then a consortium, via the Atlantic Frontier Environmental Network, funded surveys from March 1998 to March 1999.

The aims of the project were to:

- Gain information on seabird and marine mammal dispersion patterns along the continental slope, particularly in the offshore blocks licensed in the 17th and earlier offshore rounds; and
- To census several important seabird colonies on islands nearest to the licence areas.

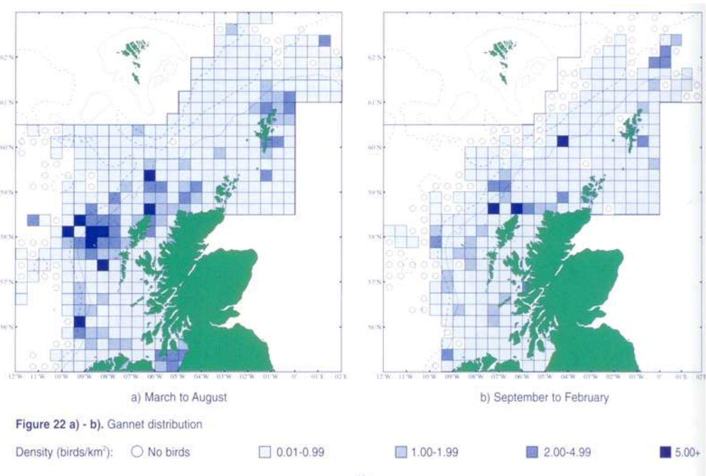


Figure 3: Seasonal dispersal of Gannet *Morus bassanus*. The maps show how overall abundance changes seasonally. It also identifies a significant feeding area west of the Western Isles (Pollock et al., 2000).

The report (Pollock et al., 2000) presents a detailed overview of the region including ecosystem drivers (ocean currents, bathymetry) and ecology (prey species and fisheries). Maps showing the monthly distribution and abundance of all seabirds, plus encounters with cetaceans are mapped (Figure 3). Drawing on the results of the surveys and other literature, the report also identifies seabird populations.

The document provides a strong baseline for risk assessment and management and has been influential in the development of environmental assessment and approvals, as well as development of oil spill contingency plans.

4.4.2 Faeroe Islands

Seabird and cetacean distribution and abundance were surveyed monthly between 1997-2000 in the north Atlantic Faroe Islands (Skov et al., 2002). The results were used to inform regional environmental impact assessment of oil exploration and the development of oil spill contingency plans. As in the Atlantic Frontier (section 4.4.1), data are presented on a species by species basis but are also combined, in species groups, to represent different levels of risk associated with oil spills (section 4.5.2).

4.4.3 Falkland Islands

Between February 1998 and January 1999, seabirds and marine mammals were systematically surveyed in the waters around the Falkland Islands (White et al., 1999) as part of environmental assessments. This was done due to a perceived threat from oil spills, after drilling began in Falkland Island waters in 1998. A subantarctic island, the Falklands are not dissimilar to New Zealand in terms of their composition of seabirds and cetaceans. Both have a coastal *Cephalorhynchid* dolphin, several species of penguin (which are particularly vulnerable to surface pollution) and numerous albatross.

4.4.4 Port Phillip Bay Channel Deepening Project

Comprehensive line transect surveys for seabirds and marine mammals were done as part of an environmental assessment for capital dredging of Melbourne's Port Phillip Bay (AES, 2003, 2004a, b). Approximately 75 days of survey were done, covering the entire 2000km^2. Surveys were completed over two seasons and repeated once for areas of greatest concern. This field work was done at a finer resolution than the other examples in this section. This is because it focused on a specific development, whereas the others were done for more strategic planning.

The results provided numerically quantitative data on the risk of shipping collision and oil spills, as well as dredging impacts, for all areas of the Bay. Results were compared to studies from ten years earlier, which included some satellite and radio-tracking of penguins from the multi-million dollar "Penguin Parade". Conclusions about the areas of greatest benefit to penguins, from the separate studies, were identical. This improved confidence in the line transect survey results, to identify areas of least concern.

Results were also compared to modelling of hydrodynamic processes and ecology. They revealed new information to explain the distribution of seabirds (including penguins) and marine mammals in Port Phillip Bay, which included a significant counter-current that developed only during winter. This knowledge further improved confidence in the interpretation of results and its application to assessing spatial and temporal ecological risk.

Data were also reanalysed and used for the Oil Spill Response Atlas (OSRA) (section 4.5.1). This was in response to the perceived risk of oil spills, as a result of increased vessel traffic through Port Phillip heads, which includes tankers visiting refineries.

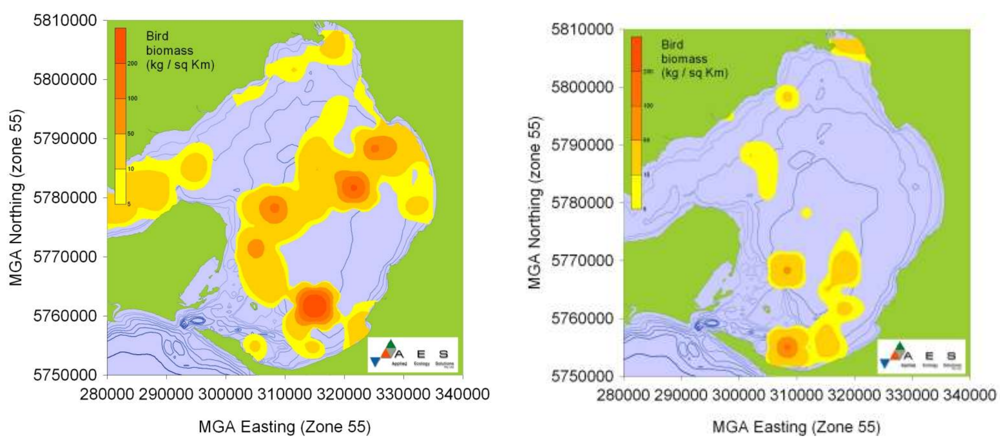


Figure 4: Biomass of seabirds in Port Phillip Bay in summer (right) and winter (left). Data reveal the enormous difference in risk between the two seasons.

As with many of the other studies detailed above, cetacean data were incorporated into the assessment but were overlaid on seabird distribution information, revealing similarities in the distribution of both groups. This is to be expected, since they predate the same species. Collection of cetacean data alone would have been prohibitively costly. The seabird data on the other hand, was gathered rapidly and provided enough information to inform decisions about activities throughout the Bay.

4.5 OIL SPILL RISK ASSESSMENT

Ecological impact assessment is essentially a risk assessment (EIANZ, 2009). It is designed to provide clarity about the level of consequence that will arise given how likely a particular incident will occur.

Assessment of risk is done with consideration of both likelihood *and* consequence, the latter of which is established through the application of ecological evidence and a process of deductive reasoning (section 2.4.2). Because 'risk' is defined as both likelihood and consequence, serious "adverse effects" would usually be foreseeable, for areas of environmental sensitivity. As stated in subsection 3(f) of the RMA, "effect" also means "any potential effect of low probability which has a high potential impact".

Where there are high or extreme risks with low likelihood, it is prudent to develop contingency plans. National oil spill response plans may already exist but it is highly unlikely that they contain decision-support information about biodiversity risk at sea, or site-specific information for making decisions about, for example, application of dispersant. Again, seabird and other ecological data collected systematically can help this process.

4.5.1 Case Study, Port Phillip Bay

Extensive seabird data was gathered throughout open-water areas of Port Phillip Bay in comprehensive systematic line-transect surveys in 2003 and 2004 as part of the Port of Melbourne Corporation (PoMC) Channel Deepening Project (AES, 2003, 2004a, b). Distance sampling methods (Bibby et al., 2000; Buckland et al., 1993; Fasham et al., 2005; Mustoe et al., 2005) permitted the calculation of absolute density and numbers of birds in the Bay in two seasons: summer (approximately November to February) and winter (approximately June to September). (AES, 2003, 2004a, b).

Data were reanalysed using vulnerability algorithms to broadly define mid-water areas of high, low and medium risk for oil spills. (Carter et al., 1993; Skov et al., 2002; Tasker et al., 1987; Tasker et al., 1990; Williams et al., 1995).

This resulted in vulnerability maps, such as the one in Figure 5. These are now contained within the Oil Spill Response Atlas (OSRA) for Port Phillip Bay.

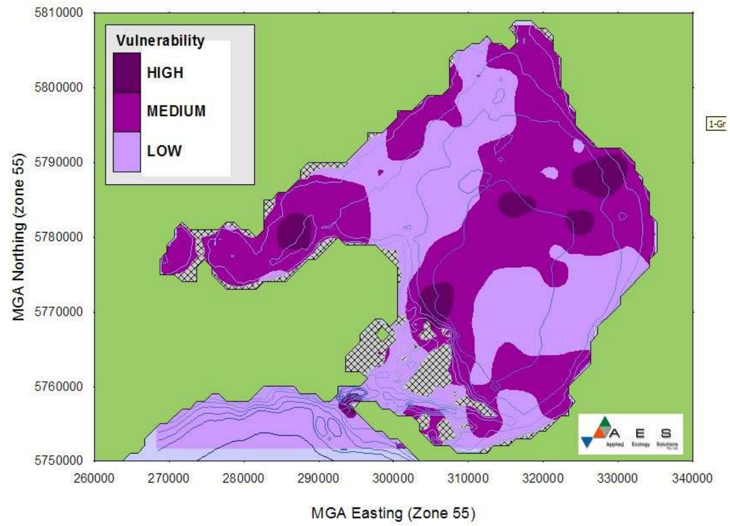


Figure 5: Vulnerability of seabirds to surface pollutants in Port Phillip Bay (June to September)

4.5.2 Case Study, Faroe Islands

Seabird and cetacean distribution and abundance were surveyed between 1997-2000 in the north Atlantic Faroe Islands (section 4.4.2). The results were used to inform development of oil spill contingency plans. Data collection and results are presented by month.

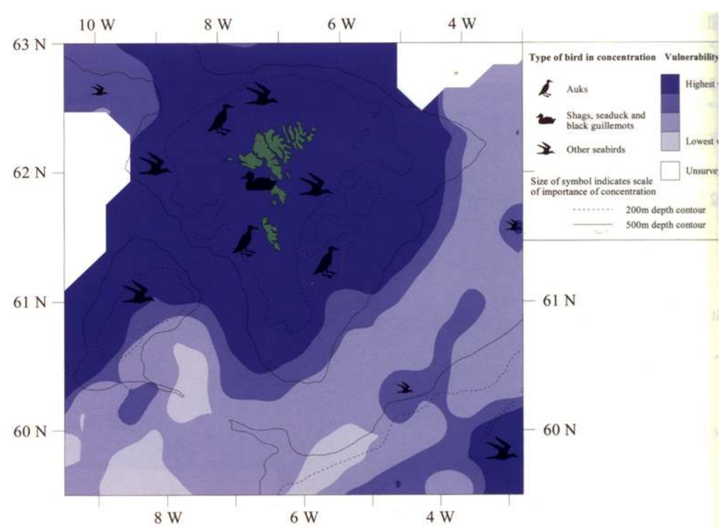


Figure 6: Seabird vulnerability to surface pollution in waters surrounding the Faroe Islands.

4.6 Other Marine Studies

Other marine studies may be needed to inform development applications, especially where particular ecological values are exposed to risk and there is a lack of data to quantify this risk. For example, where there is the need to remove or smother seabed (e.g. dredging, marine installations) or otherwise alter the local marine environment (e.g. underwater noise, warm water or other effluent). These studies would tend to be focused on specific locations where impacts are direct.

In addition, it may be necessary to map other marine fauna or fish over large areas. Such studies are inherently difficult and costly, either due to the need for underwater studies or low density of animals. In a short period it is hard to render useful spatial knowledge related to biodiversity processes, due to problems of temporal and spatial variation. Determining spatial resolution of data collection and analysis is one of the most critical factors in survey design (section 4.3.3 and Box 2).

One way to approach the problem is to start by reviewing the relationship between seabirds and the benthic and water-column environment. Birds such as cormorants and penguins are likely to be reliable indicators of benthic (seafloor) biodiversity, whilst shearwaters, petrels and gannets may be more indicative of areas of pelagic (upper water-column) biodiversity. Knowledge about the distribution and abundance of these communities of seabirds can help to target studies appropriately. Fieldwork can provide information on areas of importance for other groups such as marine mammals and help identify sampling locations related to important processes. As with seabirds, random mapping does not provide even coverage and further targeted work will still be needed. Systematic sampling is largely out of the question due to cost.

Within chosen sampling locations, consideration may be given then to the use of Remote Operated Vehicles (ROV) and Automated Underwater Vehicles (AUV) for seabed mapping. AUVs are particularly useful for remotely monitoring relatively large areas of seabed in short periods.

Importantly, these and other environmental studies on physical processes and water quality need to address the ecosystem-based objectives of the RMA and the relevant Regional Plan. To integrate them together largely requires an understanding of ecology at the outset, as this is what guides where such data is collected, how it is collected and how it is analysed.

5. DEVELOPING EVALUATION CRITERIA

At the heart of environmental assessment is the need to evaluate the 'significance' and therefore acceptability of any predicted change or loss against a pre-determined set of criteria.

As discussed in section 2.4.2, significance is measured both in terms of context and intensity. The intensity of an effect will be determined by the ecological and other environmental studies done during project scoping and further detailed investigation (section 3.1). This will reveal information, for example, on the percentage of species populations or habitats likely to be affected and the frequency, duration and magnitude of effects likely to arise from development e.g. oil spills, noise, human disturbance, habitat removal etc.

These measures do not tell us what the context is. To ascertain that, it is convenient to use an established set of criteria, such as the ANZECC *Guidelines for Establishing the National Representative System of Marine Protected Areas* (ANZECC 1998). These include:

- Ecological importance
  - contributes to maintenance of essential ecological processes or life support systems;
  - contains habitat for rare or endangered species;
  - has a high species diversity;
  - contains components/habitat on which other species, species-communities or systems are dependent – *e.g.* nursery areas, juvenile areas, feeding, breeding or rest areas, primary production areas; and
  - is a contained or isolated self-sustaining ecological unit;
- State, national or international importance – areas qualifying for listing under policies and agreements for biodiversity conservation (e.g. marine protected areas);
- Uniqueness – unique species, populations, communities or ecosystems as well as unique or unusual geographic features;
- Productivity – populations or communities with high natural biological productivity;
- Vulnerability –susceptibility or low resilience to natural processes;
- Biogeographic importance;
- Naturalness – the degree the area has been protected from human induced change.

This process of evaluating importance begins during the scoping phase of the assessment. The range of factors would be considered in turn, applying knowledge gained from community consultation and literature review. Field investigations may broaden or tighten the scope of the evaluation, depending on what is found.

What follows is a brief case study for one species, King Shag (Box 2). This is the type of information that would feed into an assessment of the importance of a region proposed for development. Note, this is only one example for a single species. The process would more importantly, need to look at species communities, habitats and processes and how these are linked.

Box 2: Case Study: The importance of Tasman Bay, Golden Bay and Marlborough Sounds for New Zealand King Shag **(*Phalacrocorax carunculatus*)**.

Abundance, Distribution and Range

King Shag is endemic to the Marlborough Sounds and the population is estimated at only 645 individuals (BirdLife International, 2004).

The biggest colony of 32 % of all the birds is situated at Trio Island. Some smaller colonies nearby are Stewart Island and Rahui-nui Island both with 4% of the total population (Schuckard 2006a).

Most King Shags from Trio Islands and Stewart Island feed southwest and west of the Trio Islands and some fly through the French Pass into Tasman Bay (Schuckard 2006b).

The entire range of King Shags as a species is considered to be approximately 1,100km^2 (BirdLife International, 2004).

Behaviour

King shags are diving birds that prey mainly on fish. They feed on a range of prey including benthic fish such as flounder and pelagic Clupeoids such as Anchovy (Butler, 2003). Maximum consumption of prey such as anchovy is likely to occur during early chick rearing periods, as this species has far greater trophic energy content.

King Shags spend significant time foraging below the surface in sheltered bays and inlets. Whilst foraging, they need to regularly return to the surface for air. Their daily movements are likely to be partially dictated by currents and tides, so they will regularly move feeding location or fly to and from colonies.

King Shags nest mostly out of reach of high seas but sometimes as low down as 1m above sea level (Marchant & Higgins, 1990).

Conservation Status

King Shag is listed by the International Union for the Conservation of Nature as "Vulnerable" to extinction (BirdLife International, 2004).

Vulnerability

- Existing threats and pressures

Human disturbance, gill-netting, shooting, marine farms and predation at colonies by rats are considered to be existing pressures on the population (Butler 2003). However, the population is considered to be stable (BirdLife International, 2004).

- Susceptibility to impacts

Due to the exceptionally small population (~645 birds) and very small overall range including feeding areas (~1,100km^2), the entire King Shag population is highly susceptible to one-off catastrophic events. Any substantial loss of habitat, prey or direct mortality is likely to remove a substantial percentage of the adult breeding population. Adult survivorship amongst most seabirds is a key driver in population regulation.

International, State or Local Biodiversity Importance

King Shag is listed as Vulnerable to extinction by the IUCN (BirdLife International, 2004).

Based on its low population level, King Shag is listed by the Department of Conservation as Nationally Endangered in New Zealand (Miskelly et al 2008).

Policy Requirements

The *New Zealand Coastal Policy Statement 1994* states that it is a national priority for the preservation of the natural character of the coastal environment to protect significant habitats of indigenous fauna in the environment by avoiding or remedying any actual or potential adverse effects of activities on the following areas:

- habitat important to regionally endangered or nationally rare species and ecological corridors connecting such areas; and

- areas important to migratory species, and to vulnerable stages of common indigenous species, in particular wetlands and estuaries.

The New Zealand Biodiversity Strategy states the need for DoC and MFish to "identify and protect threatened species".

If an oil spill by either wind, current or both is passing through French Pass, 40% of the total population is under threat. King Shags from Rahuinui Island will be in serious problems in case of an emergency. Also King Shag roosting along the rock stacks between French Pass and Pahakorea Point will have big problems in case of a blow out.

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Although the example above is only a brief analysis, it is a clear-cut example of how ecological evidence is used to evaluate the importance of one component of the region's biodiversity. In this case, the species is nationally endangered but the same logic may apply to non-threatened species, if they have value both in terms of the ecosystem or indigenous culture.

In this case, the species is statutorily protected and a controlling aspect in the approval of any development that might affect it. However, it also serves a function in understanding the importance of the environment, by fulfilling criteria cited in ANZECC (above). It is a matter of ecological importance, of national and international significance and within the limited areas it forages, may be a significant component of natural processes.

The case study above does not go as far as to establish the actual evaluation threshold for the species but this could be done during the scoping phase of the environmental assessment. As an example, the Stockyard Hill wind farm development (Victorian, Australia) has assessed potential collision-risk for Brolga, a statutorily listed species. Field studies and computer simulation modelling have determined the likely number of birds to be affected by the wind turbines. Simultaneously, a Population Viability Analysis (PVA) was commissioned. This has provided evidence for the minimum number of birds that could be killed across the state, without causing the population to decline. The theory is that so long as the cumulative total number of birds 'at risk' remains lower than this number, it meets statutory requirements to conserve the species.

This is a good example of ecological assessment best practice. The work was done during scoping so it provided the developer with an early 'heads up' about the potential level of constraint. It also provides the decision-making authority with relevant scientific information to consider for approval.

Risk analysis cannot always be so precisely quantitative but the principle is the same. Such a process would be repeated for all ecological assets (species, habitats, communities and ecological processes) identified as important or notable, during scoping. Once thresholds of acceptable change have been set, the process of designing the development can begin, so it avoids, minimises or is able to remedy likely impacts, and maintain risk within acceptable bounds. Field data is collected to both inform the likely level of risk but most importantly, as evidence of the likely value of management measures on managing risk.

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