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**Environmental  
Performance Indicators:  
An analysis of potential  
indicators for terrestrial  
biodiversity.**

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for the Environment by:  
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Signposts for sustainability

**Title:** **An Analysis of Potential Indicators for Terrestrial Biodiversity**

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# Executive Summary

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## Terrestrial biological diversity

Biological diversity is the variety of all life on earth; plants, animals and micro-organisms, the genes they contain and the ecosystems they form. It includes:

- genetic diversity
- species diversity
- ecosystems diversity

In this report terrestrial biodiversity includes terrestrial species and ecosystems above mean high water springs. This report does not specifically address freshwater wetlands as these are addressed directly in a separate freshwater biodiversity technical paper.

Special features of New Zealand's terrestrial biodiversity include:

- an exceptionally high level of endemism
- taxa that evolved to some degree as functional equivalents of "missing" taxa
- complex ecosystem structures
- a high vulnerability to introduced plants and animals
- a high level of extinctions since humans arrived 1000 years ago.

Today nearly 1000 taxa have been identified as threatened and many terrestrial ecosystems communities have been considerably reduced in extent. Many of the remaining ecosystems/communities have been considerably modified by alien biota, fragmentation and various human activities (e.g. biota harvesting), especially in lowland areas.

While protected areas include nearly 30% of New Zealand's land area, many coastal and lowland ecosystems/communities are poorly represented in New Zealand's network of protected areas.

## This Report

The purpose of this report is to review potential terrestrial biodiversity indicators developed through a series of workshops held by the Ministry for the Environment between February and June 1998. This review was required to address the following for each of the potential indicators:

- an explanation of the indicator
- identification of the relevant terrestrial biodiversity issues (as developed in the indicator development process)
- relevant national policy goals
- current research, monitoring and databases
- possible methodology and reporting
- an analysis of the usefulness and practicality of the potential indicator.

## The potential indicators

This table summarises the main recommendations/suggestions for each of the reviewed indicators:

| Potential Indicator   | Summary   |
|---|---|
| TB 1. The numbers, percentage and timing of extinctions in selected taxonomic groups  | This indicator can be implemented now for the better-known taxonomic groups. Incomplete taxonomy in many groups means that the percentage of extinctions should only be calculated for well-known taxonomic groups. The timing of extinctions will often only be known at a general level.  |
| TB 2. The number of taxa in different IUCN threat classes   | The IUCN criteria do not adequately address many of the special features of archipelagoes such as New Zealand. These criteria should be included because they provide internationally comparable data. It is recommended that this indicator be amended as follows: <i>The number of taxa in different IUCN and New Zealand threat categories</i> . The New Zealand criteria which are being developed, will need to address the special nature of New Zealand terrestrial environments. The system used by the Department of Conservation to prioritise threatened species conservation actions would not be suitable for reporting the status of threatened species because it uses a range of criteria in addition to the threat status of particular species. |
| TB 3. Relative abundance and distribution of selected indicator species compared to historic and current baselines  | Indicator species need to represent trends in a range of species and ecosystem processes. It is suggested that: <ul style="list-style-type: none"> <li>• Kiwi (all species) be included as a stage 1 indicator</li> <li>• Kokako and yellowhead be included as provisional stage 1 indicator species subject to further discussion on their representativeness</li> <li>• the New Zealand robin be considered as a stage 2 indicator species if resources permit</li> <li>• the other suggested species not be pursued as indicator species</li> </ul>  |
| TB 4. The extent of indigenous vegetation compared to historic and current baselines  | This indicator can be implemented as a stage 1 indicator for the general vegetation classes included within the land cover database. More resources will be required if more detailed typing of vegetation is required on a nation-wide basis.  |
| TB 5. The ratio of indigenous species to alien species in different habitat types.<br>TB 9. The area free from alien mammal predators, alien mammal herbivores and all alien mammals<br>TB 12. The distribution and abundance of selected alien species<br>TB 13. The number of invasive weeds species<br>TB 15. The rate of establishment (naturalisation) of alien species by type, by area | It is suggested that these potential indicators be revised as follows: <ul style="list-style-type: none"> <li>• <i>the distribution (range) and relative abundance of selected invasive weed species</i></li> <li>• <i>the distribution (range) and relative abundance of selected alien predator and herbivore pests</i></li> <li>• <i>the area free from alien mammals</i></li> <li>• <i>the ratio of naturalised alien species to indigenous species for selected taxonomic groups (e.g. birds, vascular plants).</i></li> <li>• it is suggested that potential indicator TB 15 <i>The rate of establishment of alien species by type by area</i> not be further pursued.</li> </ul>   |

|  |   |
|--|---|
| TB 6. The condition of each terrestrial ecosystem type   | Site specific monitoring of changes in biodiversity condition is a relatively simple concept and there are many examples of current monitoring. It is however, much more difficult to monitor national trends in biodiversity condition. More work will be required to determine the most cost effective ways to do this. In spite of the difficulties, a suite of nation-wide biodiversity condition parameters should be developed.                           |
| TB 7. Changes in gross habitat fragmentation for selected representative landscapes compared to historic and current baselines   | This potential indicator could provide a useful representation of the extent of fragmentation of indigenous habitats in different locations.. The Land Cover Database could be used to provide base data for monitoring this indicator. This would mean that remnants of less than 1 hectare would not be addressed. The indicator represents landscape fragmentation and does not necessarily represent the habitat fragmentation for all species.             |
| TB 8. Changes in community structure and fragmentation for the following threatened indigenous ecosystems /habitats: dune forests, dunelands, coastal turfs, forests in areas where the rainfall is less than 1 metre, geothermal systems, salt pans, wetlands, braided riverbeds and limestone caves. | The components of this potential indicator would be addressed through other indicators. The habitats identified are probably too detailed for national scale monitoring at this stage.  |
| TB 10. The evolutionary diversity in selected taxonomic groups compared to historic and recent baselines   | This potential indicator is relatively sensitive at the local and regional scale. At the national level the indicator is less sensitive, but it would be simpler to operate and historic baselines would be easier to compile. The national level of this indicator would show trends in species extinctions and new species discovered primarily through new taxonomic work.   |
| TB 11. The genetic diversity and/or distinctiveness of valued introduced species   | It is unclear whether it is appropriate to have a national indicator measuring changes in the status of New Zealand's valued introduced species as there are few national policy goals to provide direction. From an international perspective a more relevant issue could be the potential loss of genetic material from introduced taxa that are threatened in their country of origin. The NZ EPIP may not be the most effective way to address this issue.  |
| TB 16. The percentage of threatened species protected by legislation   | This would be a relatively insensitive indicator. It is suggested that this potential indicator not be proceeded with.  |
| TB 17. The number and percentage of threatened taxa with recovery programmes   | The number of recovery plans may increase without an increase in threatened species protection/rehabilitation work. A possible alternative could be <i>the number and percentage of threatened taxa where recovery plans have been prepared; and the percentage of recovery plans where plan objectives have been met.</i> The definition of "implementation" may be problematic. These difficulties mean that this would be a low priority response indicator. |

|  |   |
|--|---|
| <p>TB 18. The percentage and area of different ecosystems and habitats remaining that are legally protected in reserves</p> <p>TB 19. The percentage and area of the historical baseline for each ecosystem/habitat type that is legally protected today</p>         | <p>The use of an indicator(s) identifying progress towards achieving the goal of a representative network of protected areas is strongly endorsed. More work would be required to determine the most appropriate parameters to measure.</p>   |
| <p>TB 20. The area under restoration programmes by programme type</p>  | <p>It is unclear which activities would constitute restoration as opposed to protection and maintenance activities (especially in respect to alien biota control). This potential indicator does not relate the extent of restoration that is being done to what is required. This would be difficult to determine because it would depend on the outcomes sought by society.</p> |
| <p>TB 21. The percentage and area of each ecosystem/habitat type covered by comprehensive pest control management programmes</p> <p>TB 22. The percentage of the range of each of the major alien species where that species is under active and ongoing control</p> | <p>This potential indicator should be addressed in the Pests, Weeds and Diseases strand of the EPIP.</p>  |

## Purpose of This Report

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This is one of several reports reviewing potential biodiversity indicators for the Environmental Performance Indicators Programme. Other reports address marine biodiversity (Froude,1998b) and freshwater biodiversity (Froude,1998c).

The purpose of the EPI Programme is to develop a set of national environmental indicators for State of the Environment Reporting. The Ministry for the Environment is coordinating the development of this programme under an April 1993 cabinet directive.

The purpose of this report is to review potential indicators for freshwater biodiversity proposed by working groups that met during 1998. This review was required to address the following for each of the potential indicators:

- An explanation of the indicator
- Identification of the relevant marine biodiversity issues used in the indicator development process
- Relevant national policy goals
- Current research, monitoring and databases
- Possible methodology
- An analysis of the usefulness and practicality of the potential indicator (commentary).

Details of the indicator development process that led to these potential indicators can be found in the EPI Programme terrestrial and freshwater biodiversity discussion document (Ministry for the Environment, 1998a). Recent negotiations between the Ministry for the Environment and the Department of Conservation led to the incorporation of a modified set of proposed terrestrial indicators in that document.

# Biological Diversity Introduction

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## Defining Biological Diversity

The Convention on Biological Diversity defines biological diversity as "the variability among living organisms from all sources including inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes diversity within species, between species and of ecosystems."

Biological diversity is, therefore, the variety of all life on earth: plants, animals and microorganisms, the genes they contain and the ecosystems they form. It includes:

- genetic diversity
- species diversity
- ecosystems diversity

## Genetic diversity

Each species consists of one or more populations of individuals. Because different populations have limited genetic mixing, they tend to diverge genetically because of mutation, natural selection and genetic drift. Natural selection and genetic drift are the main forces leading to genetic diversity within species (Smith, 1994).

Under natural selection the most fit individuals leave more offspring than less fit individuals. Genetic drift results in chance fluctuations in allele frequencies between generations. In small populations these random changes may result in a loss of alleles. This will decrease the genetic diversity in these populations.

In general, a loss of genetic diversity occurs through genetic drift (migration can counteract this) and through the selective removal of specific genotypes. Any activities or processes that selectively harvest individual types or severely decrease population size will change the genetic structure of small populations (Smith, 1994). Froude (1998a) discusses changes in genetic diversity resulting from the selective harvest of certain size classes of fish by fisheries activities.

## Species diversity

This is the most obvious level of biological diversity. When species richness is viewed as the sole component of biodiversity, as is often is (Norse, 1994) this can mean that maximum species richness becomes a target or a value in itself. High species richness at a site may not relate directly to a site's relative value for biodiversity conservation, as a site with maximum species richness may reflect an intermediate level of disturbance and reasonably resilient species.

## **Ecosystem diversity**

Ecosystems differ not only in the species composition of the communities, but also in their physical structures and what the species in their communities do (function). For example the composition, structure and functioning of a lowland podocarp forest, manuka shrubland and an alpine herbfield are very different. The pathways of energy flow and the proportions of organisms performing particular functions also differ markedly between ecosystems. Individual ecosystem types, for example indigenous forests, also differ due to different physical conditions such as varying amounts of rainfall.

## **New Zealand's terrestrial biological diversity**

Diamond (1990) described New Zealand as one of the world's biological prizes. The special features of the terrestrial biota that led to this description include:

- An exceptionally high level of endemism (species not found anywhere else on earth). For example more than 75% of indigenous plants, and all indigenous reptiles, amphibians and mammals (bats) are endemic to New Zealand.
- A number of major taxa are “missing” from New Zealand. For example terrestrial mammals, terrestrial snakes, land turtles and salamanders are not represented in the indigenous fauna.
- Taxa that have evolved to some degree as functional equivalents to the “missing” taxa. This has rarely occurred elsewhere. New Zealand examples include moa, takahe and kakapo which acted like herbivores; and the short tailed bat and giant weta which acted like mice.
- Complex ecosystem structures and a strong juxtaposition of different ecosystem types in the landscape.

Other special features of New Zealand's terrestrial biodiversity are:

- A high vulnerability to introduced plants and animals. This is the result of the first three bullet points above combined with a temperate maritime climate and dynamic geological and geomorphic processes.
- A high level of extinctions since humans arrived 1000 years ago. For example 43 terrestrial bird species have become extinct in that time.

Today nearly 1000 taxa have been identified as threatened (Taylor & Smith, 1997). In addition many terrestrial ecosystems/communities have been considerably reduced in extent. The pre-European extent of mature kauri forest has been reduced by 99.5%, kahikatea forest has been reduced by 98% and lowland podocarp hardwood forest has been reduced by 85% (Froude et al, 1986). Many of the remaining terrestrial ecosystems/communities have been considerably modified by alien biota, fragmentation and various human activities (eg. biota harvesting), especially in lowland areas.

## **New Zealand terrestrial habitat conservation**

In 1996 a total of 7 976 475ha of land were protected under the National Parks Act 1980, Conservation Act 1987, Reserves Act 1977 and Wildlife Act 1953. This included private land protected under the Reserves and Wildlife Acts 1953. It does not include private land protected under the Queen Elizabeth II National Trust Act 1977. While these protected areas include nearly 30% of New Zealand's land area, many coastal and lowland ecosystems/communities are poorly represented in the network of protected areas. Much of the protected lands are on steep and mountainous country.

## Review of Potential Terrestrial Biodiversity Indicators

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This report reviews a series of potential terrestrial biodiversity indicators which were developed through a series of workshops run by the Ministry for the Environment between February and June 1998. These workshops included representatives of the scientific community, relevant government agencies, regional councils, territorial local authorities, and community/sector groups.

The indicators are:

- TB 1. The numbers, percentage and timing of extinctions in selected taxonomic groups.
- TB 2. The number of taxa in different IUCN threat classes.
- TB 3. Relative abundance and distribution of selected indicator species compared to historic and current baselines.
- TB 4. The extent of indigenous vegetation cover compared to historic and current baselines.
- TB 5. The ratio of indigenous species to alien species in different habitat types
- TB 6. The condition of each terrestrial ecosystem type.
- TB 7. Changes in gross habitat fragmentation for selected representative landscapes compared to historic and current baselines.
- TB 8. Changes in community structure and fragmentation for the following threatened indigenous ecosystems/habitats: dune forests, dunelands, coastal turfs, forests in areas where the rainfall is less than 1 metre, geothermal systems, salt pans, wetlands, braided riverbeds, limestone caves.
- TB 9. The area free from alien mammal predators, alien mammal herbivores and all alien mammals.
- TB 10. The evolutionary diversity in selected taxonomic groups compared to historic and current baselines.
- TB 11. The genetic diversity and/or distinctiveness of valued introduced species.
- TB 12. The distribution and abundance of selected alien species.
- TB 13. The number of invasive weed species.
- TB 14. The number of applications approved for the entry of new taxa into New Zealand.
- TB 15. The rate of establishment of alien species by type by area.
- TB 16. The percentage of threatened species protected by legislation.
- TB 17. The number and percentage of threatened taxa with recovery programmes.
- TB 18. The percentage and area of different ecosystems and habitats remaining that are legally protected in reserves.
- TB 19. The percentage and area of the historic baseline for each ecosystem/habitat type that is legally protected today.
- TB 20. The area under restoration programmes by programme type.
- TB 21. The percentage and area of each ecosystem/habitat type covered by comprehensive pest control management strategies.
- TB 22. The extent of the range of each major alien species where that species is under active and ongoing control.

The review format for each indicator consists of:

- an explanation about the indicator and what it could show (rationale)
- identification of the relevant terrestrial biodiversity issues used in the indicator development process
- relevant national policy goals
- existing monitoring, research and databases
- possible methods for implementing the indicator
- a commentary which analyzes the usefulness and practicality of the indicator
- a list of related indicators

Stage 1 indicators are those that can technically be implemented now, while stage 2 indicators are those that require further development work. The Ministry for the Environment is using the Pressure-State-Response mode for indicator development. Pressure indicators are those that represent threats to the environment; State indicators represent the environment's condition; while Response indicators represent society's responses to the pressures, on and the state of, the environment.

## **Scope of the terrestrial biodiversity technical paper**

This paper addresses terrestrial biodiversity. This includes terrestrial species and terrestrial ecosystems down to mean high water springs. It does not specifically address freshwater wetlands as these are addressed directly in the freshwater technical paper (Froude, 1998c).

Marine biodiversity is addressed in Froude (1998b). General indicators relating to the land are addressed in Ministry for the Environment (1997, 1998b).

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### **TB 1. The numbers, percentage and timing of extinctions in selected taxonomic groups**

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Proposed state indicator, stage 1.

#### **Explanation**

Although New Zealand was one of the last areas to be settled by humans, it has a poor record in terms of species loss. Since humans arrived approximately 700-800 years ago, the following are known to have become extinct (Taylor & Smith, 1997):

- 32% of indigenous land and freshwater bird species (43 species and nine sub species)
- 18% of endemic seabirds (4 species out of 22)
- 3 frog species (out of seven species)
- at least twelve invertebrate species
- one fish species (out of 29 species)
- one bat species (out of three species)
- possibly three reptile species
- possibly 11 plant species

It should be noted that there is a high level of uncertainty because the taxonomy of some of these groups is poorly known. Often we do not know what has been lost.

Tilman et al (1994) states that once a critical threshold of habitat loss occurs (approximately 60-80%) it takes only a small amount of further loss to cause a significant increase in species extinctions. As New Zealand's habitat loss is approaching this level, there may be a new wave of species extinctions. In New Zealand the area of domesticated land is estimated to be 63% (Taylor & Smith, 1997) and the percentage of significantly disturbed habitat is estimated to be 73%. (World Resources Institute, 1994).

Currently nearly 1000 indigenous taxa have been identified as threatened. One of the worst affected groups is the endemic land and freshwater birds, 3/4 of which are threatened (Taylor & Smith, 1997).

## **Issues**

- New Zealand's biota is both highly distinctive and highly vulnerable to the adverse effects of habitat destruction and alien biota. Today many taxa have a threatened status.

## **Policy goals**

- Ensure the survival of all indigenous species in their natural communities and habitats (Reserves Act,s3)
- Protect wildlife throughout New Zealand and New Zealand waters (Wildlife Act).

## **Current monitoring**

The Department of Conservation maintains a database that identifies priorities for the conservation of New Zealand's threatened plants and animals. Molloy & Davis (1992) developed a set of 17 criteria (refer to Appendix 2) for the Department of Conservation to use in determining its priorities for actions to conserve threatened plants and animals. These criteria address the following 5 factors:

- Taxonomic distinctiveness
- Status of the species
- Threats facing the species
- Vulnerability of the species
- Human values

Panels of experts have been used to assess mosses, vascular plants, birds, fish, terrestrial invertebrates, reptiles and amphibians. Other taxonomic groups have not been assessed.

In 1994 (Tisdall, 1994) 403 species were included in categories: A (highest priority threatened species): B (second priority threatened species): and C (third priority threatened species).

A further 408 species were placed in categories I,O,M and X. Category X species are those which have not been sighted for a number of years but may still exist. Category I species are those for which little information exists, but based on existing evidence are considered to be threatened. Category O species are those which are threatened in New Zealand but are known to be secure in other parts of their range. Category M species are those which are rare or localized and of cultural importance to Maori. It is intended that future reviews of species ranking will be undertaken as required.

## Methods

This indicator may not be able to directly use the existing Department of Conservation database on priorities for the conservation of New Zealand's threatened plants and animals. This is because the Department's ranking system does not specifically include extinctions and it is a system that ranks priorities for action. It does not provide a direct measure of the threat or rate of loss for individual species. Information on past extinctions can probably be compiled from existing information for the well known taxonomic groups. It will be difficult to compile this information for groups that are poorly known.

## Reporting

The unit of reporting would be the number of species that have become extinct by taxonomic group by time period. As the taxonomy for many groups is incomplete, the percentage of extinctions per taxonomic group will only be able to be calculated for some groups (eg. birds). In many cases it will be difficult to identify the precise timing of extinctions. Because of this reporting should be based on broad time periods.

The presentation of information could be by way of bar graphs showing the number of extinctions by time period for different taxonomic groups. Where percentages are known these could be presented in pie graph form.

## Commentary

This indicator can be implemented now for the better known taxonomic groups. There will be difficulties identifying the precise timing of extinctions and so they will probably be reported in broad time periods only. The incomplete taxonomy in many taxonomic groups can be addressed by:

- only calculating percentage extinctions for well-known groups such as birds
- recognizing that some taxa may become extinct without them being recognized as taxa.

If a taxon has not been recognized then its extinction will also not be recognised.

## Linkages to other indicators

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### **TB 2. The number of taxa in different IUCN threat classes**

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Proposed state indicator, stage one-two.

## Explanation

The IUCN status categories (IUCN, 1994) are as follows:

- Extinct (there is no reasonable doubt that the last individual has died).
- Extinct in the wild (the taxon is thought to be extinct in the wild, but is still present in either cultivation or in a zoo).
- Critically endangered (the taxon is facing an extremely high-risk of extinction in the wild in the immediate future).
- Endangered (the taxon is not critically endangered but is facing a very high-risk of extinction in the wild and the near future).
- Vulnerable (the taxon is not critically endangered or endangered but is facing a high-risk of extinction in the wild in the medium-term future).
- Lower risk (the taxon does not satisfy criteria for any of the above categories).
- Conservation dependent (these are taxa which are the focus of a continuing taxon specific or habitat specific conservation programme targeted towards the taxon in question. If this programme ceased then the taxon would qualify for one of the threatened categories within a period of five years).
- near threatened (taxa which do not qualify for conservation dependent, but are close to qualifying for vulnerable status).
- least concern (taxa which do not qualify for conservation dependent or near threatened status).
- Data deficient (there is insufficient information to assess the risk of extinction. Listing a taxon here does not mean that it is threatened or of lower risk, but it does acknowledge the possibility that future research may show that threatened classification is appropriate).
- Not evaluated (the taxon has not yet been assessed).

The criteria defining these categories are detailed in Appendix 1.

## Issues

- New Zealand's biota is both highly distinctive and highly vulnerable to the adverse effects of habitat destruction and alien biota. Today many taxa have a threatened status.
- The reduced range and population sizes of many indigenous species is likely to have reduced the genetic diversity of those species.

## Policy goals

- Develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations (Convention on Biological Diversity).
- Ensure the survival of all indigenous species in their natural communities and habitats (Reserves Act,s3).
- Protect wildlife throughout New Zealand (Wildlife Act).

## Current monitoring

Refer to the current monitoring/research section in potential indicator TB1: The numbers, percentage and timing of extinctions in selected taxonomic groups.

## Methods

The implementation of this indicator would not be able to directly use the Department of Conservation database that identifies priorities for the conservation of New Zealand's threatened plants and animals. This is because the criteria used to compile the Department's database include a much wider range of matters than the status of individual species.

It may be possible for the review panels (described in the current monitoring section for indicator TB1) to assess species against the IUCN criteria as well as the criteria the Department uses (Molloy & Davis, 1992) to prioritise species for conservation actions.

## Reporting

The unit of reporting would be the number of taxa in each IUCN (and New Zealand) threat category. The data could be presented in the form of bar graphs.

## Commentary

The IUCN classification system suits continental areas. It does not address many of the special features of archipelagos such as New Zealand. In island systems many taxa naturally occupy extremely restricted habitats. This is certainly the case in New Zealand where a number of taxa naturally have a restricted distribution and relatively low numbers of individuals. De Lange & Norton (1998) give a number of examples for plants including:

- Plants that are to confined specific and uncommon substrates such as ultramafics (eg *Carex ophiolithica*) or calcareous substrates (eg *Clematis marmoraria*).
- Plants that are restricted to disturbed environments which can be uncommon in some landscapes (eg kakabeak).
- Plants that are restricted to specific environments (eg *Melicytus flexuosus* is restricted to sites with well drained, fertile soils with cold frosty winters and warm dry summers).
- Plants that are uncommon because of the speciation resulting from recent evolution (eg *Myosotis* species).

In their evaluation of systems for ranking uncommon and threatened species de Lange & Norton (1998) state that a significant problem with the IUCN system is that it assumes that all uncommon species are threatened. In New Zealand this assumption is often not valid because many species can be naturally uncommon but under no immediate threat. de Lange & Norton propose an alternative system that recognises that not all uncommon species are threatened species. Their system also provides for taxa that are still nationally widespread but are in serious decline (e.g. cabbage tree). They state that while they focus on plants the system could be applied to all biota. Further development would be required before this system could be applied more generally, including to the marine environment.

At present the Department of Conservation uses criteria developed by Molloy & Davis(1992) to prioritize species for conservation action. This was reported in the current monitoring section of potential indicator TB1 *The numbers, percentage and timing of extinctions in selected taxonomic groups* using the 1994 species assessments from Tisdall, (1994). As the criteria used by the Department evaluates a range of factors in addition to the status of individual species, it is not appropriate to use these criteria directly to report on changes in the number of threatened species.

It is recommended that the proposed indicator be reworded as follows:  
***the number of taxa in IUCN and New Zealand threat categories.***

In spite of the problems with using the IUCN categories it is appropriate that they be used for international reporting as they are the international standard for classifying threatened species. The revised indicator recognizes this and suggests that a complementary system be developed to meet New Zealand's specific requirements. As discussed in Froude (1998b & 1998c) this system should also recognize and address the specific requirements of New Zealand's marine and freshwater environments. A modified de Lange & Norton system may provide the basis for a more appropriate New Zealand system.

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**TB 3. Relative abundance and distribution of selected indicator species compared to historic and current baselines**

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Proposed state indicator, stage 1-2.

**Explanation**

The purpose of this proposed indicator is to use the trends in several "indicator" species to represent the trends in relative abundance and distribution for a wider range of species and/or particular ecological communities. During the working group sessions a variety of species were suggested including: the kiwi, kereru, robin, kokako, yellowhead, bellbird, tui, whitehead, rifleman and various land snail species. The group focused on the distribution of indigenous bird species because birds were considered to be sensitive to a variety of pressures and much data had already been collected for a number of species. The group sought to include a variety of species that as a group include the following attributes:

- a high degree of evolutionary distinctiveness;
- keystone species;
- iconic species;
- species that are declining in range and/or numbers;
- species that people have regular contact with.

Plants were not included because the group could not identify plant species that would be useful as indicators throughout New Zealand. Other taxonomic groups were not included because it was considered there was insufficient information about them.

## Issues

- New Zealand's biota is both highly distinctive and highly vulnerable to the adverse effects of habitat destruction and alien biota. Today many taxa have a threatened status.
- The reduced range and population sizes of many indigenous species is likely to have reduced the genetic diversity of those species.

## Policy goals

- Ensure the survival of all indigenous species in their natural communities and habitats (Reserves Act, s3)
- Protect wildlife throughout New Zealand (Wildlife Act).
- Promote the maintenance of viable populations of species in their natural surroundings (Convention on Biological Diversity, article 9).

## Current monitoring

### 1. Kiwi species (Department of Conservation)

*Nationwide kiwi monitoring scheme.* This programme measures the number of kiwi calls observed during two-hour counts on 4-6 nights at 4-6 sites in a region. During timed counts each call is noted and the sex, distance and direction of the bird is given. This provides a simple, rapid and crude assessment of changes in the abundance of all taxa of kiwi throughout New Zealand. Baseline data is available using 1993-96 counts. It is intended that these counts will be repeated at five-year intervals at the same sites. If a significant change is detected from the baseline counts then the counts will be repeated the following year.

*Kiwi call scheme.* This programme (which began in 1980) measures the number of kiwi calls during a timed count of variable duration. This provides a simple and rapid assessment of kiwi distribution and a crude measure of abundance. In this programme the public are encouraged to fill in Kiwi Call Scheme cards in likely kiwi habitats. During timed counts each call is noted and the sex, distance and direction of the bird is given. The data are added to a national database of call counts from each 10 km square. The data are plotted as the mean calls per hour of listening for each 10 km square. This monitoring information has been used to identify the distribution of kiwi and gaps in the knowledge of kiwi distribution.

*Intensive monitoring of banded populations of kiwi.* This programme (which began in 1978) monitors the density, sex ratios, age structure, survival and recruitment of kiwi in specified areas. The purpose of this programme is to determine the rate and patterns of change in at least one population from each of 5 taxa of kiwi, some with and some without management. In this programme kiwi within a specified area are caught; measured to determine age and sex; banded; and radio tagged (to determine territory dimensions and whether the bird is paired). Each of the 14 sites is visited approximately every five years. A file is maintained of all banded birds in each of the 14 study populations. Maps show the distribution of pairs.

*Intensive monitoring of radio tagged kiwi populations.* This programme (which began in 1983) monitors the survival of adult kiwi, nesting successes and causes of nest failures,

social structure, survivorship of chicks and dispersal. The purpose of this programme is to accurately assess the dynamics of kiwi populations in relation to management. In this programme kiwis are radio tagged in specified study areas. Survivorship, productivity, social structure and dispersal are measured by following the life history of each bird over several years. The data is added to databases of survivorship and breeding productivity, and comparisons are made between different management methods/treatments.

## 2. Kereru (Department of Conservation)

Kereru are being monitored annually in a variety of North and South Island sites. These include Mainland Island sites and paired non-treatment sites, some offshore islands and the Chatham Islands. "Mainland Island" are locations on Mainland New Zealand where there is comprehensive and integrated indigenous biota and ecosystems. The parameters being monitored in the Kereru programme are an index of abundance, and display-flight frequency. The techniques used are:

- five minutes counts of pigeons at marked sites
- ten minute counts of display flights from vantage points

A manual has been prepared (Mander et al, 1998).

The Auckland Regional Council has a kereru monitoring programme in one of its reserves.

## 3. Robins (Department of Conservation)

Robin populations are monitored in a number of areas because of their regionally threatened status. Areas for monitoring include:

- sites of new robin releases
- alien mammal control (using poison baits) sites where robins occur

## 4. Kokako recovery programme, North Island (Department of Conservation)

This programme began in 1973. There are a number of monthly to annual surveys. The parameters measured are:

- possum and rodent indices
- the total number of birds

In several sites the nesting success and sex ratio are also measured. Monitoring methods include territory mapping, banding and monitoring of banded birds and the radio tracking some birds.

## 5. Yellowhead recovery programme, South Island (Department of Conservation)

This programme began in 1986 in the Hawden Valley and later elsewhere. There is annual monitoring. The parameters measured are:

- beech seedfall
- indices of bird density
- total counts of banded populations (Eglinton and Dart Valleys).

Methods include five minute index counts on permanent transect lines. In some sites each breeding pair is banded and monitored.

## 6. Other species monitoring programmes (Department of Conservation)

Froude (1998a) described a number of individual species monitoring programmes, particularly for threatened species. These include monitoring programmes for: northern rata condition; populations size and spatial extent of *Leptinella nana* (pygmy button daisy); the size and conditions of three species of mistletoe; population sizes and age structure of *Muehlenbeckia astonii*; etc

### **Methods**

This indicator would use existing monitoring programmes, possibly with some extensions.

### **Reporting**

The unit of reporting would depend on the species involved. For example with kiwi it could be:

- the change in distribution for each kiwi species
- the estimated number of individuals for each kiwi species

Data presentation could be by way of maps and bar graphs/histograms.

### **Commentary**

Indicator species should represent more than themselves. For many species their status and behaviour just reflects what is happening to them. This particularly applies to species which are subject to special management e.g. kakapo, stitch bird and tuatara. There is insufficient information about many species to know whether changes in their distribution and abundance reflect similar changes in other species. Species with *naturally* restricted distributions would not generally be considered as national indicator species.

The potential representativeness of a number of the animal species identified by the working group can be questioned. Some of listed species respond to pressures in a distinctive way (eg. land snails). Others are subject to a unique set of pressures (eg. kereru). For others we have insufficient information to know whether the identified species could represent other species (eg. bellbird).

Some of the identified species were included because they have been or may still be a regular part of human lives especially in urban areas (i.e. tui, bellbird, rifleman and whitehead). If there is concern and/or interest about changes in the distribution and abundance of these nationally relatively common species in urban areas, it would be appropriate to monitor changes in the urban areas of concern rather than nationally.

Monitoring numerical changes in the distribution and numbers of national indicator species requires considerable data and therefore expenditure. The tight constraints on conservation spending mean that this type of monitoring is probably limited to existing monitoring programmes or variations of these. The current species monitoring programmes have been described above (see also Froude, 1998a). At this stage Department of Conservation programmes address the national abundance and distribution for each of the kiwi species, kokako and yellowhead. There are also limited nationwide Department of Conservation monitoring programmes for robin and kereru.

It would be appropriate to use kiwi as national indicator species. There is an ongoing national electronic database of kiwi distribution and abundance. Kiwis are iconic species and are the subject of much public interest. They reflect predator pressures (mustelids, cats, and dogs) and to a lesser extent habitat loss.

There are good databases for kokako and yellowhead, although they are not as electronically accessible as the kiwi database. Yellowheads are restricted to the South Island and they represent predator pressures (especially mustelids). Kokako are restricted to the North Island and represent both predator pressures (especially possums and rats) and habitat loss. The distribution of both of these species has reduced and their total numbers have declined. Accordingly some people have questioned whether these species should be national indicator species.

A potentially good national indicator species could be the New Zealand robin. The robin reflects predator pressures (e.g. mustelids and rodents) and pressures resulting from habitat destruction and modification. The robin would be a good indicator species because its numbers change, either up or down depending on the nature and type of pressures. There is not yet a good national database and it would be expensive to establish this.

Another suggested indicator species was the kereru. The national monitoring program for kereru has just started. The abundance of kereru can be considered to be a measure of forest health as kereru are a major dispersal agents for the fruits and seeds of large tree species. Kereru are also subject to harvesting. Kereru patterns and trends are generally not considered to be representative of the patterns and trends in other species.

It would be appropriate to continue with this indicator: the relative abundance and distribution of selected indicator species compared to historic and current baselines.

In terms of species it is suggested that:

- kiwi (all species) be included as a stage 1 indicator species
- kokako and yellowhead be included as provisional stage 1 indicator species subject to further discussion on their representativeness given their limited geographical distribution.
- New Zealand robin be considered as a stage 2 indicator species if resources permit
- the other listed species not be pursued as national indicator species

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#### **TB 4. The extent of indigenous vegetation cover compared to historical and current baselines**

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Proposed state indicator, stage 1

## Explanation

Changes in ecosystem extent and condition are two key elements in the biodiversity component of the indicators programme. This indicator can be adjusted to the level of information available and what is practical to measure. For example this indicator could monitor changes in indigenous forest cover or it could go further and monitor changes in different types of indigenous forest (e.g. kauri forest, lowland podocarp forest). Digitized data provides a range of data manipulation opportunities.

## Issues

- There has been a considerable reduction in the extent of indigenous ecosystems. The extent of that reduction varies with the environment and location. Few indigenous lowland and coastal (above mean high water springs) ecosystems remain intact except for the South Island West Coast, Fiordland and Stewart Island.
- Little unmodified indigenous grassland remains.
- Some forest types (e.g. kauri, kahikatea, lowland podocarp forest) have significantly decreased in extent with little remaining today. For example the pre-European extent of mature kauri forest has been reduced by 99.5 percent, kahikatea forest has been reduced by 98 percent and lowland podocarp hardwood forest has been reduced by 85 percent. Many forest areas have been damaged, particularly by alien biota.
- Less than 10 percent of the original mosaic of wetland systems remain today. Many remaining wetlands have been degraded to varying extents by invasions of alien plants, fish and waterfowl; modifications to hydrological regimes; or barriers to fish passage. The loss of wetland extent and diversity is continuing.
- Less than ten percent of coastal dune lands remain in a nearly natural condition.

## Policy goals

- Preserve representative samples of all classes of natural ecosystems and landscapes (Reserves Act,s3).
- Complete the terrestrial protected areas network, including wetlands, grasslands and other ecosystems under represented in reserves (E2010).
- Preserve the natural character of the coastal environment (RMA,s6).
- Protect significant indigenous vegetation and significant habitats of indigenous fauna (RMA,s6c).
- Maintain and enhance the total area of New Zealand's remaining indigenous forests (E2010,6.1).
- Protect ecosystems unique to the coastal environment and vulnerable to modification (NZCPS, 1.1.2).

## Current monitoring and databases

### Land Cover Database and associated projects

In 1996 New Zealand secured access to reliable coverage of SPOT satellite imagery via the Tasmanian Earth Resources Satellite Station. This provides 20m multi-spectral data that is being used by the Ministry of Agriculture and Forestry to develop the New Zealand Land Cover Database. It is intended that this database will provide complete national terrestrial coverage (currently 60%) of 14 mutually exclusive land cover units. These units are:

- urban area
- urban open space
- primarily pastoral
- primarily horticultural
- plantation forestry
- shrublands
- major shelter belts
- tussock grassland
- indigenous forest
- bare ground
- inland wetland
- coastal wetland
- lakes
- coastal sand

Spatial resolution is 20 m and the minimum mapping unit is one hectare. It is intended that the database will be updated at regular intervals. In addition to the satellite imagery extra data will come from stratified sampling to improve accuracy. The data is digitized and orthorectified to the New Zealand Map Grid. It can be combined with other digitized and orthorectified geographic databases such as land tenure boundaries and road lines.

More detailed division of land cover is possible using both the original satellite imagery and ancillary data. Examples to date include:

- classifying indigenous tussock grassland by identifying changes in species composition;
- identifying and mapping more detailed land cover types in several council districts.

### *Ecological Survey of New Zealand's Indigenous Forests*

This is a series of maps and descriptions prepared by J. L. Nichols showing the broad classes of indigenous forests in New Zealand. The maps are at 1:250 000 scale with each of the 27 maps covering approximately one distinct ecological region. The map is based on data collected during the New Zealand Forest Service volumetric surveys of the 1950s.

### *Various regional or district maps showing the extent of different vegetation classes.*

There are a variety of vegetation maps with different scales and levels of detail. Some maps exist at the regional scale, for example the maps of past and present vegetation in the Waikato Region. Local scale maps have been prepared for a variety of purposes including reserve management, land-use planning education and research purposes.

## Methods

The Land Cover Database provides the basic framework and ongoing monitoring effort for this indicator. Information from the Nichols Forest Class Maps and various other mapping programmes can be used to define detailed vegetation types where this is required. The SPOT image and the judicious use of supplementary information can lead to more units being defined (Thompson, 1998). The collection of field information in areas where data levels are low and/or where there have been recent changes in land cover would further improve the accuracy of this indicator.

Existing historical land cover databases and maps are usually at a relatively general level. For example there are general maps of indigenous forest extent in 1000AD and 1840AD (Froude et al. 1986) and 700AD and 1800AD (Newsome, 1987). The historical extent of other vegetation types can be estimated using information on geology, soils, climate, present day vegetation patterns, fossil and/or charcoal evidence. It is suggested that the historical baseline be 1000AD (pre-human times).

The extent of indigenous vegetation cover should probably be monitored approximately every ten years.

## Reporting

The unit of reporting could be the area and percentage cover of the different indigenous vegetation classes. Reporting could be at different levels of detail depending on the information available. Another unit of reporting could be the percentage of the original extent (1000AD) of various indigenous vegetation cover classes that remain. In both cases reporting could also be by spatial unit (for example environmental domain or ecological region/district or by council region). An ecologically based unit would be preferred over an administrative unit whose boundaries can change at any time. Data presentation could be by way of maps and graphs.

## Commentary

This indicator can be implemented as a stage 1 indicator for the general vegetation classes included within Land Cover Database. More resources will be required if more detailed typing of vegetation is required on a nationwide basis. This would however, be highly desirable especially for those types of vegetation where change is likely. Existing information on the historical extent of indigenous vegetation classes provides a database that can be developed further as resources allow.

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## **TB 6. The condition of each terrestrial ecosystem type**

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Proposed state indicator, stage 2

### Issues

- There has been a considerable reduction in the extent of indigenous ecosystems. The extent of that reduction varies with the environment and location. Few indigenous lowland and coastal (above mean high water springs) ecosystems remain intact except for the South Island West Coast, Fiordland and Stewart Island.

- Little unmodified indigenous grassland remains.
- Some forest types (e.g. kauri, kahikatea, lowland podocarp forest) have been significantly decreased in extent with little remaining today. For example the pre-European extent of mature kauri forest has been reduced by 99.5%, kahikatea forest has been reduced by 98% and lowland podocarp hardwood forest has been reduced by 85 percent. Many forest areas have been damaged, particularly by alien biota.
- Less than ten percent of coastal dune lands remain in a nearly natural condition.
- Less than ten percent of the original mosaic of wetland systems remain today. Many of the remaining wetlands have been degraded to varying extents by: invasions of alien plants, fish and waterfowl; modifications to hydrological regimes; or barriers to fish migration. The loss of wetland extent and diversity is continuing.

### **Policy goals**

- Complete the terrestrial protected areas network, including wetlands, grasslands and other ecosystems under represented in reserves (E2010).
- Preserve the natural character of the coastal environment (RMA,s6).
- Protect significant indigenous vegetation and significant habitats of indigenous fauna (RMA,s6c).
- Maintain and enhance the total area of New Zealand's remaining indigenous forests (E2010,6.1).
- Protect ecosystems unique to the coastal environment and vulnerable to modification (NZCPS,1.1.2).
- Ensure as far as possible the survival of all indigenous species of flora and fauna.... in their natural communities and habitats. Preserve representative samples of all classes of natural ecosystems and landscapes (Reserves Act,s3)

### **Explanation**

In the last 700-800 years humans and alien biota have changed the condition of probably all indigenous terrestrial ecosystems in New Zealand. While a number of factors have lead to a decline in extent for many indigenous ecosystems the following factors increase the likelihood that remaining ecosystems will be significantly modified:

- they are highly fragmented, especially compared to pre-human times
- they are highly vulnerable to weed invasion (e.g. fertile sites, sites close to human settlement)
- sites have high animal pest numbers and/or are grazed by domestic stock
- sites have been directly modified by human activities such as harvesting, burning, drainage, trampling and transport corridors.

These factors are not independent and in some areas a number of factors work together to significantly reduce the condition of indigenous ecosystems. Sites most at risk tend to be small remnants near human settlement and intensive agricultural land uses.

Different terrestrial ecosystems respond differently to the various threats. Some ecological communities are particularly vulnerable to modification (e.g. indigenous coastal dune land communities) while others are more resilient (e.g. mid altitude beech forest).

Human conservation management of terrestrial ecosystems is a major factor in determining how much impact the actual and potential pressures have on a particular site. For example a Mainland Island with intensive alien plant and animal management will be less modified than an equivalent unmanaged area.

Condition is usually assessed in particular sites. Assessments of condition (or aspects of it) can take many forms as the next section on current monitoring shows.

## **Current monitoring/databases**

### **1. National Indigenous Vegetation Survey Database**

This is a large vegetation database. While it is managed by Landcare Research inputs have come from many sources. Initially much of the information came through the New Zealand Forest Research Institute. Now much of the information comes from the Department of Conservation (eg. the Protected Natural Area Programme, Sites of Special Biological Interest and resurvey of existing plots).

There is extensive coverage of indigenous forests (especially montane and subalpine forests); moderate coverage of grasslands and shrublands; and minor coverage of wetlands, exotic vegetation and managed vegetation such as pine plantations. Parameters measured include vegetation composition, relative species abundance and vertical structure (height class categories). General site information is also collected.

Information comes from relocatable transects with more than 100,000 plots from throughout New Zealand. There is detailed information about the absolute abundance of individual species in the approximately 12,000 permanent forest plots and approximately 5000 permanent plots for grasslands and other non woody vegetation. Over one third of these plots have been remeasured at least once. The data collected for the NIVS database largely comes from standardized methodology which is described in Allen, (1992 & 1993) and Wiser & Rose, (1997).

The earliest data comes from the national forest survey in the 1940s and 1950s. The oldest permanent plots data from the 1950s. The longest running set of permanent plot measurements runs from the 1950s to the 1990s. Some permanent forest plots have been remeasured up to ten times in 28 years.

More than 75% of the permanent plots and more than 60% of survey plots are georeferenced. The georeferencing process is continuing. The data is held on manual and electronic databases. The latter provides for integration with other Landcare Research databases, such as the national soils database. Information from the National Indigenous Vegetation Survey Database has been used in a wide range of projects.

## 2. Exclosure plots

Paired fenced and unfenced exclosures show browsed and unbrowsed plots side-by-side. These provide a semi quantitative assessment of how forests recover without browse. Parameters that are measured include: the abundance of each species within size classes; height and/or diameter at breast height. Levels of foliage browse on key species are also monitored. The observed forest condition is often matched with estimates of animal pest numbers. Exclosure plots occur in forests throughout New Zealand. Many plots were initially established in the 1960s. There is regular ongoing monitoring of many of the plots.

## 3. Foliage loss/browse indices

These indices represent the damage caused by possum browsing on susceptible "indicator" tree species (e.g. pohutukawa and kohekohe). Parameters measured are: foliage cover/loss; level of possum browse; damage to trunks; die back and recovery; flower and fruit abundance. Information is matched with trap catch and bait take data to determine the effectiveness of possum control operations in terms of vegetation recovery. There are a range of other techniques for assessing possum and other animal damage to indigenous vegetation. For example the Auckland Regional Council has developed alternative equivalent techniques to monitor the effect of browsing animals on indigenous vegetation.

## 4. Photographic monitoring using photo points

Regular photography at set photo points is a common method used to show changes in vegetation condition, especially for grasslands. This technique is often used in combination with various quantitative monitoring techniques to assess major changes in the structure and/or condition of particular vegetation types such as shrublands, wetlands and grasslands.

## 5. Mainland Island restoration programmes

The birds component of the monitoring programmes for mainland islands track the trends in populations of diurnal forest birds and the productivity of kiwi, kokako, kereru, and robins in managed and unmanaged areas for the 10 mainland islands sites. Five-minute bird counts are used for common species to obtain index counts of abundance. Some species are banded and monitored (e.g. robin) and some species are radio tagged (e.g. kiwi). Key influences such as possums are also monitored.

## 6. Offshore islands bird monitoring programmes (e.g. Kapiti and Mana)

Index counts of forest birds and absolute counts of seabirds and key threatened species are used to determine the effectiveness of pest eradication programmes.

## 7. Forest regeneration, Tiritiri Matangi Island

In this programme the annual height increment and survivorship of seedlings and randomly chosen permanent plots are monitored over time.

## 8. Assessment of national natural character (Stephens, in press)

Stephens identifies five main characteristics of natural character that are affected by human activities.

| <b>Human activity</b>                         | <b>Attribute of natural character affected</b> |
|---|--|
| Hunting, fishing, logging, fire and clearance | Plant and animal biomass and richness          |
| Introduced animal pests                       | Predation and herbivory regimes                |
| Introduced plant pests                        | Competition                                    |
| Land management and use                       | Light, nutrients, water, physical disturbance  |
| Fragmentation and transport                   | Connection and isolation                       |

None of the five listed characteristics of natural character can be directly measured.

Stephens suggests the following alternative process to assess national natural character:

- identify land cover classes within environmental domains (ecologically similar units) as these reflect human modification
- to further differentiate natural vegetation cover classes, natural character can be calibrated with estimated biodiversity loss. For example an isolated secondly forest remnant in the Waikato contained 128 native plant species in 1933 (probably the same as its pre-human content) but only 83 plant species in 1994 (Whaley et al,1997). This means that its present vascular plant diversity represents about 65% of its pre-human content. The site was probably used by up to 46 bird species (Atkinson & Millener,1990) but is now used by about 9 indigenous bird species which suggests that the site sustains only about 20% of its former avian biodiversity. Surveys of 116 remnant kahikatea forest stands in the Waikato suggests that the species richness of indigenous plants, beetles and snails is moderate in comparison to nearby large forest tracts but indigenous bird diversity is low (Burns,1997). Stephens assessed that secondary forest remnants in the Waikato sustain about 50 -60% of their former indigenous biodiversity.
- Animal pest distribution data can be used to construct an index of alien consumption pressure which would be based on the number of alien consumers present and the community guilds they feed on
- Plant pest distribution data could be used to construct an index of the intensity of alien competition which would be based on the extent of each vegetation tier occupied by alien plant species.
- Land use information can be used to assess physical and chemical disturbance and the associated change in the resource base.
- A fragmentation index could be derived from current land cover data using a combination of relevant spatial measures such as size, number of fragments, distance to nearest neighbour and edge to core area ratio.

Stephens notes that this index does not address the loss of distinctive elements of biodiversity. In this approach data can be aggregated or disaggregated as required. The Department of Conservation is trialing this type of approach to identify the condition of areas it manages and the extent to which the condition changes with different management regimes.

## Methods

There are several approaches that could be used for this indicator. Current methodology/research suggests two main approaches:

- a multi-factorial index addressing pressure and state elements such as that proposed by Stephens
- measured condition in a wide range of representative sites. This could be based on methods used by monitoring programmes included in the National Indigenous Vegetation Database.

Further work will be needed to determine the most appropriate and cost-effective approach for assessing changes in the condition of New Zealand's indigenous ecosystems. Whatever approach is chosen will need to include both public and private lands under a variety of management regimes. The measure of condition will need to reflect the outcomes of different management regimes in the proportion in which they apply to different vegetation types.

## Reporting

The units of reporting will depend on the methods chosen. It should be possible to aggregate and disaggregate data as required for reporting purposes. It may be possible to report changes in condition for different management regimes. For example:

- all indigenous dune lands
- indigenous dunelands that are legally protected
- indigenous dunelands that have no legal protection
- indigenous dunelands that are subject to restoration (defined) programmes

Histograms and graphs can be used to show changes in condition.

## Commentary

The monitoring of changes in condition for a particular site is relatively straightforward, although the results can sometimes be ambiguous. It is much more difficult to monitor changes in condition for all of New Zealand's indigenous terrestrial ecosystems at a national level. Irrespective of the difficulties it is essential that the potential indicators for terrestrial biodiversity include an indicator that addresses the condition of New Zealand's indigenous terrestrial ecosystems.

More work will be required to determine the most cost-effective way of doing this. Investigations into current monitoring and research programmes suggests two alternative approaches as discussed in the methods section. Whichever method is chosen will need to address both public and private lands and the implications of different management regimes in the same vegetation cover class/type.

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### **TB 7. Changes in gross habitat fragmentation for selected representative landscapes compared to historic and current baselines**

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Proposed state indicator, stage 1

## Explanation

Fragmentation of habitat is a major threat for many terrestrial species. It is also a significant threat for many terrestrial ecosystems especially in lowland areas. Taylor & Smith (1997) stated that farms, settlements and roads now occupy more than 90% of New Zealand lowland areas.

Much of the indigenous habitat remaining in lowland areas is extensively fragmented and exists as islands of indigenous habitat in a matrix of human production land uses. Often those indigenous habitats that remain have been extensively modified by the “edge effect” and in some cases no core habitat remains.

This indicator addresses fragmentation at the landscape scale. It should however, be recognized that the habitat and matrix are not the same for all indigenous species. For species that need extensive areas of intact indigenous forest habitat (e.g. kereru) few if any indigenous forest remnants in an area might be considered as habitat. Conversely some other native species use some parts of human production/residential landscapes as habitat (e.g. tui). This is in addition to the habitat provided by the indigenous forest remnants.

## Issues

- Many terrestrial ecosystems have become extensively fragmented. This can result in local extinctions and ongoing degradation including invasions by alien biota.

## Policy goals

- Regulate or manage processes and activities that have a significant adverse effect on biological diversity (Convention on Biological Diversity, article 8)
- Avoid, remedy or mitigate any adverse effects of activities on the environment (RMA, s5).
- Maintain and enhance the total area of New Zealand's remaining indigenous forests (E2010).
- Ensure, as far as possible, the survival of all indigenous species of flora and fauna in their natural communities and habitats (Reserves Act,s3b).
- Restore and rehabilitate the natural character of the coastal environment (NZCPS,1.1.5).

## Current monitoring and research

Habitat fragmentation has generally not been monitored for New Zealand landscapes. Various overseas studies have assessed changes in habitat fragmentation in particular locations (eg. Saunders, Hobbs & Arnold, 1993; Thomas, Kirkby & Reid,1997). These studies have tended to focus on changes in the percentage of indigenous habitat and sizes of those remnants. There have also been studies about the impacts of habitat fragmentation on individual species (e.g. Arnold, Steven & Weeldenburg, 1993).

## Methods

For the purposes of this potential indicator it is suggested that changes in various spatial parameters be measured for indigenous habitats larger than one hectare. One hectare is the minimum area identified in the Land Cover Database.

It is suggested that the Land Cover Database be used as the base data for monitoring this indicator. This is because the LCDB will be updated every five years and the data will be digitized to allow easy manipulation. Information on the LCDB was presented in current monitoring section for indicator *TB4 the extent of indigenous vegetation cover compared to historic and current baselines*.

Indigenous habitat fragmentation results in a number of landscape changes. It would therefore be appropriate to use an index that includes a selection of parameters such as: the percentage of habitat remaining; size of remnants; distance to nearest remnant; perimeter to area ratio. Another possible parameter could be the edge area to core area ratio. As the depth of the edge effect varies between different vegetation types, this parameter would require additional information to that provided to in the LCDB. It is suggested that the perimeter to area ratio would be a satisfactory alternative given the scale of monitoring.

## Reporting

The unit of reporting could be: the extent of fragmentation (e.g. fragmentation index) per unit area (e.g. environmental domain, ecological region or district or council area). The boundaries of the unit areas will need to be digitized. It is suggested that ecologically based areas be used rather than administrative ones whose boundaries can be changed.

Presentation could be by way of maps and histograms showing the level of the index and/or the parameters that make up the index. To aid interpretation it could be useful to show a pre-disturbance benchmark for each area used.

## Commentary

This potential indicator could provide a useful representation of the extent of fragmentation of indigenous habitats in different locations. It would be a stage 1 - 2 indicator depending on the amount of work that would be required to test the appropriate combination of factors to include in the fragmentation index.

As with any national indicator it will be important to understand its assumptions and limitations. In this case:

- the indicator represents landscape fragmentation and does not necessarily represent the habitat fragmentation for all species
- areas less than 1 hectare in size will not be addressed because this is less than minimum resolution size for the Land Cover Database.

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**TB8. Changes in community structure and fragmentation for the following threatened indigenous ecosystems /habitats: dune forests, dunelands, coastal turfs, forests in areas where the annual rainfall is less than 1 metre, geothermal systems, saltpans, wetlands, braided riverbeds and limestone caves**

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Proposed ecosystems state indicator, stage 2.

### **Explanation**

This potential indicator seeks to apply the general condition indicators to specific threatened ecosystems/habitats that have become very limited in extent. The listed habitats were those identified by the working group. Some of these habitats would be more appropriately addressed in the freshwater biodiversity strand.

### **Issues**

There has been a considerable reduction in the extent of indigenous ecosystems. The extent of that reduction varies with the environment and location. Few indigenous lowland and coastal ecosystems remain intact except for the South Island West Coast, Fiordland and Stewart Island.

### **Policy Goals**

- Ensure, as far as possible, the survival of all indigenous species of flora and fauna in their natural communities and habitats. Preserve representative samples of all classes of natural ecosystems (Reserves Act, s3).
- Complete the terrestrial protected areas network, including wetlands, grasslands and other ecosystems under represented in reserves (E2010).
- Protect significant indigenous vegetation and significant habitats of indigenous fauna (RMA, s6c).

### **Current monitoring and research**

Please refer to indicators *TB 4: the extent of indigenous vegetation cover compared to historical and current baselines; TB 6: the condition of each terrestrial ecosystem type; TB 7: changes in gross habitat fragmentation for selected representative landscapes compared to historic and current baselines.*

## Commentary

The components of this potential indicator are covered in indicators *TB 4: the extent of indigenous vegetation cover compared to historical and current baselines*; *TB 6: the condition of each terrestrial ecosystem type*; *TB 7: changes in gross habitat fragmentation for selected representative landscapes compared to historic and current baselines*. While the communities/habitats specifically addressed in this indicator are very important they are probably too detailed for national scale monitoring at this stage. This potential indicator is more appropriate for agency level monitoring and reporting, although it may in the medium to long term become possible to aggregate local/regional monitoring data to report this proposed indicator nationally.

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| <b>TB 5.</b>  | <b>The ratio of indigenous species to alien species in different habitat types</b>              |
| <b>TB 9.</b>  | <b>The area free from alien mammal predators, alien mammal herbivores and all alien mammals</b> |
| <b>TB 12.</b> | <b>The distribution and abundance of selected alien species</b>                                 |
| <b>TB 13.</b> | <b>The number of invasive weed species</b>  |
| <b>TB 15.</b> | <b>The rate of establishment (naturalization) of alien species by type by area</b>              |

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Proposed pressure indicators (5,12,13,15) and proposed state indicator (9); stage 1-2

### Explanation

Alien species have had, and continue to have, a significant effect on New Zealand's indigenous terrestrial species and ecosystems. New Zealand's biota evolved in isolation from other landmasses for 80 million years and so they are particularly vulnerable to alien species such as predating and browsing mammals. Alien species act as one or more of predator (e.g. possums, rats, mustelids); herbivore (e.g. possums, deer, goats); or competitor (e.g. invasive alien plants, possums). Some indigenous species are so vulnerable to alien species that they only/mainly survive on predator free islands (e.g. saddleback) or in mainland areas subject to intensive pest management (e.g. kokako).

Alien species have completely disrupted ecosystem structures and functioning in some locations. Often it is the combined effect of a suite of alien species that is so damaging. For example goats and deer browsing the understory and possums browsing the canopy have led to forest collapse in a number of locations (e.g. parts of the Ruahine Range).

Invasive weed species are having an increasingly disruptive effect on many indigenous ecosystems. Timmins & Williams (1987) identified certain types of sites as being especially vulnerable, for example remnants on fertile lowland sites near urban areas. Indigenous terrestrial ecosystems of low stature, for example grasslands, can also be at high-risk from invasive weed species.

The suggested alien species indicators arose out of the terrestrial biodiversity workshops. As there have been some suggestions that these potential indicators overlap this report will address these potential indicators as a group.

## Issues

New Zealand is highly vulnerable to the adverse effects of alien biota because it has an evolutionary distinctive biota combined with a maritime climate and dynamic geological and geomorphic processes. Alien species threaten the survival of a number of indigenous taxa. They have also damaged, and continue to damage, entire indigenous community structures and functioning in a number of locations.

## Policy goals

- Prevent the introduction, control or eradicate those alien species that threaten ecosystems, habitats or species (Convention on Biological Diversity, article 8).
- Contain and control plant and animal pests to improve habitat and species protection and retention (E2010).
- Establish offshore and mainland islands where invader threats have been minimised (DOC Strategic Business Plan 1998-2002).
- Introduced flora and fauna will be eradicated as far as possible (New Zealand National Parks General Policy).
- Continually monitor New Zealand's status in regard to pests (Biosecurity Act, s42).
- Effectively manage or eradicate pests (Biosecurity Act, s54).

## Current monitoring

There are many monitoring programmes that address the effects of alien biota on indigenous ecosystems and some cases individual species. Some of the methodologies have been described in the current monitoring section for indicator *TB6 The condition of each terrestrial ecosystem type*. Further information on the range of monitoring programmes address that the impacts of alien species on indigenous species and ecosystems can be found in Froude (1998a).

The potential indicators being reviewed in this section focus directly on the alien species rather than the effects of those species. It is intended that there will be a more comprehensive review of alien species monitoring in the Pests, Weeds and Diseases Strand of the Environmental Performance Indicators Programme.

Agencies involved in monitoring the abundance and distribution of various alien species that affect indigenous species and ecosystems include the Department of Conservation, regional councils and in some cases territorial local authorities.

## Commentary

It is likely that the final choice of indicators for estimating the distribution and abundance of alien species as they affect terrestrial biodiversity will be made as part of the Pests, Weeds and Diseases Strand of the Environmental Performance Indicators Programme. At this stage it is suggested that the following be considered for further development as revised potential indicators TB12 and TB13 :

- *the distribution (range) and relative abundance of selected invasive weed species*
- *the distribution (range) and relative abundance of selected alien predator and herbivore pests*

These potential indicators are equivalent to the proposed marine environment indicator: *MB 11. The distribution and relative abundance of selected alien species in the marine environment.* Existing databases should be compatible with this type of indicator. It is possible that existing databases and monitoring effort will only allow changes in distribution to be monitored.

In addition would be appropriate to identify the extent of indigenous habitats free from troublesome groups of alien biota. For example, a high priority is placed on using offshore islands where alien predators and herbivores have been removed, for protecting and restoring threatened species. A suggested revised potential indicator TB9 is: *The area free from alien mammals.* The data for this indicator should be readily available from the Department of Conservation as it manages most alien mammal free areas (some of these are on behalf of private/Maori landowners).

The concept of a ratio of established alien species to indigenous species could be a useful one because it represents the level of alien invasions. An equivalent indicator has been proposed in the marine environment: *MB 12. The number of alien species established in New Zealand's marine environment and the rate of establishment.* There is a 1998 database of alien species in marine environment. That was compiled by NIWA staff who reviewed published and unpublished literature and communicated with various experts. It could be possible to operate such a database in the terrestrial environment but it would be more complex given that nearly two-thirds of the terrestrial environment is generally occupied by non-indigenous systems. Such a ratio would probably be restricted to certain taxonomic groups such as vascular plants, mammals, birds and reptiles.

It is suggested that potential indicator TB5 be modified as follows: *the ratio of naturalised alien species to indigenous species for selected taxonomic groups.* This should be more workable and it could provide information on the potential pressures from alien species. This potential indicator is of lower priority than the other suggested potential alien species indicators.

Potential indicator TB15. *The rate of establishment of alien species by type by area* would be very difficult to implement in the terrestrial environment. This is because so many alien species have established in the terrestrial environment and the timing of their naturalization is often unknown. Many of these alien species are of little concern from a biodiversity maintenance perspective. This indicator would require considerable effort to implement. It is suggested that this potential indicator not be pursued further as part of the terrestrial biodiversity strand of the EPI Programme. It could be appropriate to review it under the Pests, Weeds and Disease Strand.

## Methods

These will probably be discussed in depth in Pests, Weeds and Diseases Strand. Generally the methods should be able to build on existing central government and council databases although some clarification of agency roles would be required. It is however, unclear who would manage the database underlying the indicator addressing the ratio of alien species to indigenous species for selected taxonomic groups. It is possible that each regional council could record the naturalised alien species within selected taxonomic groups within their region.

## Reporting

This will depend on the methods chosen during work on developing indicators for the Pests, Weeds and Diseases Strand of the EPI Programme

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### **TB 10. The evolutionary diversity in selected taxonomic groups compared to historic and recent baselines.**

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Proposed state indicator, stage 1-2

## Explanation

The purpose of this proposed indicator is to monitor changes in the remaining evolutionary diversity for selected taxonomic groups from New Zealand's indigenous biota. This indicator can also include the distinctiveness of the taxa that have become extinct since the arrival of humans approximately 1000 years ago by using a prehuman historic baseline.

It is suggested that the evolutionary distinctiveness be identified by monitoring changes in phylogenetic diversity in selected taxonomic groups. The phylogenetic approach to measuring biological differences between taxa addresses the degree of difference between species in terms of the genealogical relationships between species (Williams, Vane-Wright & Humphries; 1993). A phylogenetic tree shows the genealogical relationships between taxa. These are estimated from a sample of characteristics that predict total feature diversity. The branch lengths in the tree are proportional to the total number of unique characters.

This potential indicator could demonstrate the homogenization of New Zealand's biota at the regional level. To do this it would need to assess changes in phylogenetic diversity at the regional level.

## Issues

- New Zealand's biota is both highly distinctive and highly vulnerable to the adverse effects of habitat destruction and alien biota. Today many taxa have a threatened status.
- The reduced range and population sizes of many indigenous species is likely to have reduced the genetic diversity of those species.

## **Policy goals**

- Ensure the survival of all indigenous species in their natural communities and habitats (Reserves Act, s3).
- Protect wildlife through out New Zealand (Wildlife Act).

## **Current monitoring and research**

Landcare Research New Zealand Ltd. is investigating the use of phylogenetic diversity as part of a suite of tools for monitoring biological condition at the local level. This technique is also being developed to assist decision-makers to choose reserve mixes that provide the maximum complementary in phylogenetic diversity. The technique requires a high level of taxonomic information about organisms in the taxonomic group being assessed. At present that level of information only exists for birds and terrestrial molluscs, and possibly vascular plants.

## **Methods**

The computer methodology for this indicator has been developed for New Zealand use by Landcare Research. This indicator could be implemented now for existing terrestrial molluscs and birds. Additional work would be required to incorporate extinct bird species. Vascular plants could be considered as a next stage.

## **Reporting**

The unit of reporting could be the evolutionary distinctiveness in selected taxonomic groups. The changes could be shown against the historic (prehuman) and recent (e.g. 1998) baselines.

Presentation could be by way of diagrams and histograms. Effort would be required to make this indicator readily understandable to the public and decision-makers.

## **Commentary**

This indicator has a relatively high sensitivity at the local and regional scale. In this context it can demonstrate the increasing homogenization of New Zealand's indigenous biota as the ranges of many species contract, especially those of evolutionary distinctive and vulnerable species such as the kiwi species. Reporting would then be based on ecological units such as environmental domains or ecological regions/districts. It would be more complex to operate this indicator at the regional level because the distribution of the relevant species would need to be monitored. It would also be more difficult to prepare historic baselines as prehuman species distribution in the relevant taxonomic groups would need to be known at the environmental domain or ecological region/district level.

At the national scale this indicator is much simpler to operate and historic baselines would be easier to prepare. Phylogenetic diversity is however, a relatively insensitive measure at this level because it requires extinctions and the discovery of new species to result in indicator changes. Extinctions are already measured by indicator TB1. *The numbers, percentage and timing of extinctions in selected taxonomic groups*. New species would generally result from taxonomic revisions. At the national scale this indicator would not show changes in the distribution of species, particularly range contractions.

It is unclear which agency would be responsible for monitoring this indicator.

### **Linkages to other indicators**

*TB 1. The numbers, percentage and timing of extinctions in selected taxonomic groups.*

*TB 2. Changes in the number of taxa in different IUCN and New Zealand threat classes.*

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## **TB 11. The genetic diversity and/or distinctiveness of valued introduced species**

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Proposed state indicator, stage 2.

### **Explanation**

The purpose of this suggested indicator is to demonstrate changes in the evolutionary distinctiveness of (selected) valued introduced species. Please refer to the explanation for indicator *TB 10. The evolutionary diversity in selected taxonomic groups compared to historic and recent baselines* for information about using phylogenetic diversity to show changes in the evolutionary distinctiveness of taxonomic groups.

### **Issues**

There may be a reduction in the genetic diversity of some valued introduced species.

### **Policy goals**

None at present.

### **Current monitoring and research**

Please refer to the current monitoring and research section in indicator TB10: *The evolutionary diversity in selected taxonomic groups compared to historic and recent baselines for relevant information*.

## Commentary

It is unclear whether it is appropriate to have a national indicator measuring changes in the status of New Zealand's valued introduced species as there are no confirmed national policy goals to provide direction. Two different working groups considered: potential indicators for the identified issue; and whether the issue was a significant one that should be addressed in the EPI Programme. One group considered that it would be appropriate to address this issue in the EPI Programme, while the other did not.

If it is determined that this is an appropriate issue to address through the EPI Programme then the way that this should be done needs to be clarified. One option is suggested indicator *TB11. The genetic diversity and/or distinctiveness of valued introduced species*. More work would be required to determine whether the methodology for determining the phylogenetic diversity in selected taxonomic groups for indigenous species can be meaningfully adapted for use in this indicator.

The term “valued introduced species” needs to be defined. Many valued introduced taxa are sub species, varieties and even clones. The relevance of ornamental species to this indicator should also be clarified.

From an international conservation perspective a more relevant issue could be the potential loss of genetic material from introduced species/taxa that are threatened in their country of origin. The New Zealand Environmental Performance Indicators Programme may not be a particularly effective way to address this issue.

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### **TB 14. The number of applications approved for the entry of new taxa (including varieties) into New Zealand**

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Please refer to the section addressing suggested indicators that will not be developed further.

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### **TB 16. The percentage of threatened species protected by legislation**

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Proposed species response indicator, stage 1

#### **Explanation**

This indicator seeks to consider society's responses to species at risk or potentially at risk. At present following terrestrial species are protected under New Zealand legislation:

- indigenous wildlife species as specified in the Wildlife Act 1953 and its schedules.

Threatened plant species on private land receive no legal protection unless they are incorporated within the boundaries of a protected area. Plants on public land are protected by the protected area statute (where this exists) and the Native Plants Protection Act 1934. Court judgments in 1973 and 1974 effectively excluded trees from the provisions of this Act (Froude et al, 1986).

## Issues

- New Zealand's biota is both highly distinctive and highly vulnerable to the adverse effects of habitat destruction and alien biota. Today many taxa have a threatened status.
- The reduced range and population sizes of many indigenous species is likely to have reduced the genetic diversity of those species.

## Policy goals

Protect wildlife throughout New Zealand (Wildlife Act)

## Current monitoring

The Department of Conservation administers the legislation that currently identifies protected species. The current monitoring that identifies threatened species is summarised in potential indicator *TB2: Change in the number of taxa in different New Zealand and IUCN threat categories*.

## Methods

The list of protected species can be determined from current legislation. It can easily be kept updated through regular reviews of the New Zealand Gazette which identifies any legislative amendments. Alternatively, as any amendment is likely to be administered by the Department of Conservation, that Department would know what species are protected at any time. The methods for identifying threatened species are described in potential indicator *TB2: change in the number of taxa in different New Zealand and IUCN threat categories*.

## Reporting

The unit of reporting would be the percentage of threatened species protected for each broad taxonomic group. Presentation could be by bar graphs or pie charts that show the percentage of species protected in each taxonomic group.

## Commentary

The list of protected species changes slowly and so it would not be a particularly sensitive indicator. Legislative protection of the species does not necessarily mean that the species is protected in reality. For example, although most indigenous bird species are protected under the Wildlife Act 1953, their habitat can be destroyed unless it is protected under another legislative provision.

A possible alternative indicator could be the nature and extent of species protection and rehabilitation measures. While this would be a more useful response indicator it could be difficult to determine what would be included. Other options include:

- the number and status of threatened species recovery plans; and
- the number and type of threatened species protection/rehabilitation programmes.

The first option is already being addressed in potential indicator *TB17: The number and percentage of threatened taxa with recovery programmes*. It would be difficult to

determine what type of programmes would be included within species protection/rehabilitation programmes. This is because many species programmes are also ecosystem protection/rehabilitation programmes. Ecosystem rehabilitation programmes are addressed under potential indicator *TB20. The area under restoration programmes by programme type.*

It is suggested that this potential indicator not be preceded with because: it is not a sensitive indicator and the legal protection of a species is often insufficient on its own to protect that species.

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## **TB 17. The number and percentage of threatened taxa with recovery programmes**

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Proposed species response indicator, stage 1

### **Explanation**

The intention of this indicator is to provide a representation of the protection and rehabilitation work for threatened species. Species recovery plans are non-statutory single species documents that provide direction for species recovery work. They are prepared by the recovery team. The recovery team includes staff from the Department of Conservation and other relevant agencies depending on the species involved. For example Victoria University of Wellington had a major role in preparation of the tuatara species recovery plan. Factors that are considered when setting priorities for plan preparation include: urgency/threat to various species and resource availability. Sometimes the implementation of particular plans slows when priorities change.

### **Current monitoring**

The Department of Conservation has a list of recovery plans.

### **Methods**

This indicator would use the Department of Conservation database of recovery plans. The number of recovery plans can be matched with a number of threatened species as identified in potential indicator *TB2: change in the number of taxa in different New Zealand and IUCN threat categories.*

### **Reporting**

The unit of reporting could be the number and percentage of threatened species (by broad taxonomic group) with recovery plans. Data presentation could be by way of histograms or pie graphs.

## Commentary

This would be a low-cost indicator of work on species protection and recovery. There are however, disadvantages. For example, while the number of recovery plans may increase, the protection/restoration effort may not increase if some plans are left unimplemented. A suggested alternative could be the number of species recovery plans that are implemented. A definition of implemented could be problematic. If it means any action, then it would not be a particularly helpful measure. If, on the other hand, it means that the plans objectives had been achieved then it could look as if nothing was happening for many years for some species. This would particularly be the case if ambitious objectives had been set.

An alternative could be to combine the options as follows:

*The number and percentage of threatened taxa where recovery plans have been prepared; and percentage of recovery plans where plan objectives have been met.*

It is suggested that because of the difficulties associated with developing a meaningful indicator that this be a low priority indicator.

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| <b>TB 18.</b> | <b>The percentage and area of different ecosystems and habitats remaining that are legally protected in reserves</b>      |
| <b>TB 19.</b> | <b>The percentage and area of the historical baseline for each ecosystem/habitat type that is legally protected today</b> |

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Proposed ecosystems response indicator, stage 1-2.

### Explanation

The intention of these potential indicators is to identify progress towards achieving the goal of a representative network of protected areas. This representativeness can be considered relative to a historical baseline (e.g. 1000AD, potential indicator TB19) and to what remains at the time the indicator is measured (potential indicator TB18). For example, lowland forests are only 16% of protected forests, even though they made up 50% of New Zealand's original forest area (Department of Conservation & Ministry for the Environment, 1998). Although most lowland forests have been destroyed, a relatively high percentage of that which remains is unprotected. In contrast, most remaining montane and subalpine forests are protected and these represent a relatively high percentage of their pre-European cover.

### Issues

- Many terrestrial indigenous habitats/ecosystems are under represented in New Zealand's network of protected areas. This includes: lowland forest remnants, coastal forest/shrublands/turfs, dunelands, natural shrublands, lowland grasslands, geothermal ecosystems and floodplain wetlands.

## Policy goals

- Preserve representative samples of all classes of natural ecosystems and landscapes (Reserves Act, s3).
- Protect representative examples of all indigenous ecosystems (E2010).
- Complete the terrestrial protected areas network, including wetlands, grasslands and other ecosystems under represented in reserves (E2010).

## Current monitoring

The Department of Conservation's land register identifies all areas administered by the Department, including areas that are directly managed, covenants and wildlife refuges. Each Conservancy manages its own register. The format of these registers is not standardized. The land register generally identifies the legal definition, legal status, size, relevant Gazette notices and other associated legal documents. Some conservancies have the registers on GIS but this is not standard. It is possible that Queen Elizabeth II National Trust covenants may be added to this database in future because the Department has fire management responsibilities in covenanted areas. Some conservancies also include local authority Reserves Act reserves on their databases.

Regional councils and territorial local authorities administer protected areas, although the extent of these varies considerably between councils. It is likely that councils each have some form of database of lands they manage. Not all areas under indigenous vegetation that are managed by councils are protected. In many cases the indigenous ecosystems in water supply catchments are not legally protected even where these ecosystems are of high ecological value. An example would be the upper catchments of the Hutt, Orongorongo and Wainuiomata Rivers which are managed by Wellington Regional Council. Conversely, a number of the territorial local authority reserves administered under the Reserves Act are not of ecological value as they include playing fields etc.

Councils should have some form of record of the memoranda of encumbrances they have with landowners who have been required to protect areas of indigenous vegetation as a condition of a Resource Management Act 1991 or Town & Country Planning Act 1977 consent. These records, especially for older resource consents, may not be easy to access. Jessop (1993) investigated the monitoring by territorial local authorities in the Auckland Region of covenants required as a condition of district and city council bush lot subdivision provisions. He found that many records were in confusion and that there had been no post approval monitoring.

## Methods

The identification of the location and extent of all protected areas would need to use information from several sources. This would include the Department of Conservation land registers from each of 13 conservancies, and appropriate land records from regional and district councils.

The Department of Conservation land register is digitized in some conservancies and is likely to be digitized for at least the South Island in future. Any indicator addressing the representativeness of protected areas would need to have digitized protected area databases.

Two matters need to be addressed with land registers from regional councils and territorial local authorities. The first is whether the protected lands are of ecological value. This could be addressed if: the council identifies the type of reserve and what it is used for: or the record cross referenced to the Land Cover Database to confirm the nature of the existing vegetation cover. The second matter is whether lands of ecological value held in public ownership but not legally protected, should be included in this indicator as a separate category. Such lands include many water catchment areas.

Data on memoranda of encumbrances from territorial local authorities and regional councils should be checked against the Land Cover Database to confirm the nature of the existing vegetation cover.

Once the protected area data is digitized it can be matched with a variety of other digitized databases including:

- altitude (LINZ)
- environmental domains (Landcare Research)
- existing and historical vegetation (potential indicator *TB 4. The extent of indigenous vegetation compared to historical and recent baselines*).

## Reporting

A variety of units of reporting are possible including:

- the number of hectares of protected lands within each ecosystem type
- the percentage of each ecosystem type that exists today that is legally protected
- the percentage of the original pre-European extent of each ecosystem type that is legally protected
- the percentage of each broad altitude band in legally protected areas
- the percentage of each environmental domain that is legally protected

Presentation could be by way of pie graphs, histograms and maps.

## Commentary

These potential indicators identify progress towards achieving the goal of a representative network of protected areas. They could be represented by several parameters that would collectively indicate representativeness. Reporting on the percentage of each environmental domain and broad altitude class that is legally protected should be relatively simple as digitised databases are available. The other parameters would require that information indicator *TB 4. The extent of indigenous vegetation compared to historic and current baselines* be digitised.

There are some complications associated with the use of historical baselines. For example there is a greater area of indigenous grasslands today than in prehuman times. This is because many indigenous lowland grasslands were induced as a result of forest clearing fires after the arrival of Maori, especially in the eastern South Island. There has however been considerable concern that lowland indigenous grasslands are not adequately represented in reserves and much indigenous grassland has been destroyed or damaged. If an alternative benchmark of 1840 (before the main period of European colonization) is used, this would show a considerable change in extent for indigenous grasslands and a lesser change for indigenous forests. It would be inappropriate to use different historical benchmarks for each ecosystem type.

The representativeness of protected areas is a good response indicator. More work is required to determine the most appropriate measures to use. This will depend in part of which data is accessible in a digitized form. If historical baselines are used, an appropriate one needs to be chosen. Generally it is less arbitrary to use a pre human benchmark (approximately 1000AD).

While protection targets could be useful, care would be needed if only coarse units (eg. indigenous forests) were being reported.

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## **TB 20. The area under restoration programmes by programme type.**

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Proposed response indicator, stage 1-2.

### **Explanation**

Many terrestrial ecosystems have been destroyed (see indicator *TB 4. The extent of indigenous ecosystems/habitats compared to historic and recent baselines*) and/or have been damaged by alien biota and other threatening processes (see indicator *TB6. The condition of each ecosystem type*). This indicator seeks to identify efforts to enhance and restore damaged ecosystems/habitats.

### **Issues**

There has been a considerable reduction in the extent of indigenous ecosystems. The extent of that reduction varies with the environment and location. Few indigenous lowland and coastal (above mean high water springs) ecosystems remain intact except for the South Island West Coast, Fiordland and Stewart Island.

### **Policy goals**

- Restore and rehabilitate the natural character of the coastal environment where appropriate (NZCPS, 1.1.5)
- Protect representative examples of all indigenous ecosystems (E2010).
- Prevent the introduction, control or eradicate those alien species that threaten ecosystems, habitats or species (Convention on Biological Diversity, article 8).
- Contain and control plant and animal pests to improve habitat and species protection and retention (E2010).

- Establish offshore and mainland islands where invader threats have been minimised (DOC Strategic Business Plan 1998-2002).
- Introduced flora and fauna will be eradicated as far as possible (New Zealand National Parks General Policy).
- Continually monitor New Zealand's status in regard to pests (Biosecurity Act, S 42).
- Effectively manage or eradicate pests (Biosecurity Act, s54).

### **Current monitoring**

While there is no specific monitoring of the number or area of restoration programmes, the various agencies and community groups would have records of the restoration programmes that they are involved in. Many of the restoration programmes would be monitored to measure their effectiveness in achieving the programme goals.

### **Methods**

The relevant government agencies (Department of Conservation), territorial authorities and community organizations (e.g. Royal Forest and Bird Protection Society) could be contacted at regular intervals to identify the area and type of restoration programmes that they are involved in.

### **Reporting**

The unit of reporting could be the area under restoration programmes by programme type.

### **Commentary**

It is unclear which activities would constitute restoration as opposed to protection and maintenance activities. Specific restoration programmes such as planting potential new habitat would clearly be within the scope of this indicator. It would be less clear with alien species control activities.

This potential indicator does not relate the extent of restoration is being done to what is required. The extent of restoration required on a nation-wide basis would be difficult to determine because it would depend on the outcomes society seeks for New Zealand's terrestrial biodiversity.

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| <b>TB 21.</b> | <b>The percentage and area of each ecosystem/habitat type covered by comprehensive pest control management programmes</b>    |
| <b>TB 22.</b> | <b>The percentage of the range of each of the major alien species where that species is under active and ongoing control</b> |

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It is recommended that consideration of these potential indicators be deferred to the Pests, Weeds and Diseases Strand of the EPI Programme.

## Suggested Indicators Which Will Not be Further Developed

| Suggested indicator considered   | Type     | Reasons for not developing indicator   |
|--|----------|--|
| The % biomass for selected representative sites compared to historic and current baselines           | State    | Difficult to measure and interpret   |
| % indigenous species managed by sustainable use regimes  | State    | Most of New Zealand's terrestrial production systems use introduced species. Few indigenous terrestrial species are utilized for food, fibre or timber.  |
| Indigenous biodiversity value of exotic plantations and the urban environment                        | State    | This is not suitable as a national indicator. This is generally not being monitored and would require considerable resources to do so on a national scale.   |
| Change in the extent of indigenous vegetation and habitat condition on islands                       | State    | Islands are addressed under the general extent and condition indicators TB4, TB6 as well as the indicators addressing alien species. More detailed monitoring is an agency responsibility.   |
| The area of planted forest by type   | State    | This is not an indicator of biodiversity state, pressure or response.  |
| The number of applications approved for the entry of new taxa (including varieties) into New Zealand | Pressure | Many new taxa and varieties approved for importation are probably not a risk to indigenous biodiversity. The total number of taxa may obscure information about taxa that may present a risk to indigenous biodiversity  |
| The number of consents for fire, drainage, indigenous vegetation removal etc.                        | Pressure | Different councils require resource consents for different activities. A change in the number of consents may reflect a change in council rules rather than a change in activity level. Many ecologically damaging activities do not require consent throughout much of New Zealand. |
| Change in the size of New Zealand's ecological footprint.  | Pressure | This is not really a biodiversity indicator. It would be more appropriate to address this as an overarching indicator.   |

|   |                       |  |
|---|-----------------------|--|
| The number of people in New Zealand   | Pressure              | This is part of the above potential indicator.   |
| The number of tourists visiting sensitive locations   | Pressure              | Sensitivity is context dependent. An increasing number of visitors will increase the number of sensitive locations. It would not be possible to monitor this without considerable effort. There is an unclear relationship to biodiversity.                      |
| The number of economic disincentives and/or number of incentives for biodiversity conservation                                    | Response              | This is not a biophysical indicator and so is not being pursued at this time. Incentives and disincentives operate at different levels (national, regional, local) and in different ways. It would be difficult to get meaningful measures at the national level |
| % New Zealand covered by territorial local authority planning documents that promote biodiversity protection (by type of measure) | Response              | This was not pursued because there was no agreement on the types measures that would be appropriate. Measures in plans may not reflect or lead to biodiversity improvement on the ground   |
| Number of people belonging to conservation organizations  | response              | This measure was considered to reflect changes in community attitudes rather than changes in biodiversity  |
| Changes in the attitudes of New Zealanders to biodiversity protection   | Pressure/<br>Response | This is not a biophysical indicator and so is not being considered at this time  |

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## Glossary

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Alien species: species that are not indigenous to New Zealand.

Biological diversity: "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems." (Convention on Biological Diversity).

Biological Integrity: this is the ability to support and maintain a balanced, integrated, adaptive community of organisms having a composition, diversity and functional organization comparable with natural habitats of the region (Frey, 1977). Hughes et al. define natural habitats as ones of minimal human disturbance or pre-Columbus (USA) condition. These natural habitats are benchmarks only and may not now be achievable.

Endemic: endemic taxa are only found naturally in the location being referred to. E.g. kiwi are endemic to New Zealand.

Freshwater ecosystems: for the purpose of the EPI programme these include: rivers, lakes, freshwater wetlands, geothermal ecosystems and underground aquifers.

Indigenous: indigenous taxa occur naturally in the location being referred to and may also occur naturally in other locations e.g. Australasian bittern are indigenous to New Zealand and they occur naturally in some other countries.

Keystone species: these are species whose activities are critical to the structure of the community in which they live.

Mainland islands: these are locations on mainland New Zealand where there is comprehensive and integrated management of all the major threats to indigenous biota and ecosystems.

Marine ecosystems: for the purpose of the EPI programme these include all areas below mean high water springs out to the boundary of the exclusive economic zone. Estuarine saltmarsh communities are included even if they are above mean high water springs.

Naturalised species: alien species that have become established in the wild.

Taxon: (plural=taxa) a taxon is a unit of classification that extends below the species level to include sub-species and varieties. In this report this does not include varieties developed for the horticultural industry.

Terrestrial ecosystems: for the purpose of the EPI Programme this includes natural areas above mean high water springs excluding freshwater ecosystems, and estuarine saltmarsh communities above mhws. It includes terrestrial coastal habitats such as dunelands.

## Appendix 1: IUCN Criteria for Species Status Categories

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### Extinct

A taxon is extinct where there is no reasonable doubt that the last individual has died.

### Extinct in the wild

A taxon is extinct in the wild when it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range. A taxon is presumed to be extinct in the wild when exhaustive surveys in known and/or expected habitats, at appropriate times, throughout its historical range, have failed to record an individual.

### Critically endangered

A taxon is critically endangered when it is facing an extremely high risk of extinction in the wild in the immediate future as defined by any of the following criteria:

1. An observed, estimated, inferred or suspected population reduction of at least 80% over the last ten years or three generations, whatever is the longer.
2. A population reduction of at least 80%, projected or suspected to be met within the next ten years or three generations, whichever is the larger.
3. The extent of occurrence is estimated to be less than 100km<sup>2</sup> or the area of occupancy is estimated to be less than 10km<sup>2</sup> and estimates indicate any two of the following apply:
  - there are severely fragmented populations or it exists at only one location;
  - there is continuing decline in the extent of occurrence, area of occupancy, extent and/or quality of habitat, number of locations, and number of mature individuals;
  - there are extreme fluctuations in any of the extent of occurrence, the area of occupancy, the number of locations, and the number of mature individuals.
4. The population is estimated to number less than 250 individuals and there is a continuing decline of at least 25% within three years or one generation, whichever is longer:  
**or** there is a continuing decline with severely fragmented sub populations;  
**or** all individuals are in one single sub population.
5. The population is estimated to number less than 50 mature individuals.
6. Quantitative analysis shows that the probability of extinction in the wild is at least 50% within ten years or three generations, whichever is the longer.

## Endangered

A taxon is endangered when it is not “critically endangered” but is facing a very high-risk of extinction in the wild in the near future as defined by any of following criteria:

1. An observed, estimated, inferred or suspected population reduction of a least 50 percent over the last ten years or three generations, whichever is the longer.
2. A population reduction of at least 50 percent, projected or suspected to be met within the next ten years or three generations, whichever is the longer.
3. The extent of occurrence is estimated to be less than 5 000km<sup>2</sup> or area of occupancy estimated to be less than 500km<sup>2</sup> and estimates indicate any two of the following apply:
  - severely fragmented populations or populations at less than 5 locations;
  - continuing decline in the extent of occurrence, the area of occupancy, the area and/or quality of habitat, the number of sub populations, and the number of mature individuals;
  - extreme fluctuations in any of extent of the occurrence, the area of occupancy, the number of sub populations, and the number of mature individuals.
4. The population is estimated to number less than 2500 individuals and there is either:
  - a continuing decline of at least 20% within five years or two generations, whichever is longer
  - or there is a continuing decline in the numbers of mature individuals in the population because of severe fragmentation or all individuals are from one sub-population.
5. The population is estimated to number less than 250 mature individuals.
6. Quantitative analysis shows that the probability of extinction in the wild is at least 20 percent within 20 years, or five generations, whichever is the longer.

## Vulnerable

A taxon is vulnerable when it is not critically endangered or endangered but is facing a high-risk of extinction in the wild in the medium-term future as defined by any of the following criteria:

1. There is a population reduction of the least 20 percent over the last ten years or three generations, whichever is the longer.
2. There is a projected population reduction of the least 20 percent for the next ten years, or three generations, whichever is the longer.
3. The extent of occurrence is estimated to be less than 20 000km<sup>2</sup> or the area of occupancy is estimated to be less than 2000km<sup>2</sup> and estimates indicate any two of the following apply:
  - there are severely fragmented populations or populations are less than ten locations;
  - there is a continuing decline of any of the extent of occurrence; the area of occupancy; the area and/or quality of habitat; the number of sub populations and the numbers of mature individuals;
  - extreme fluctuations in any of area of occurrence, the area of occupancy, the number of sub-populations, and the number of mature individuals.

4. The population is estimated to number less than 10 000 mature individuals and there is either;
  - a continuing decline of least ten percent within ten years of three generations, whichever is longer
  - or there is a continuing decline in the numbers of mature individuals and the population structure.
5. The population is estimated to number less than 1000 mature individuals.
6. The population is characterized by an acute restriction in its area of occupancy(usually less than 100km<sup>2</sup>) or the number of locations (typically less than 5).
7. Quantitative analysis shows that the probability of extinction in the wild is at least ten percent within 100 years.

### **Lower risk**

A taxon is lower risk where does not satisfy the criteria for critically endangered, endangered or vulnerable taxa. There are three sub categories of lower risk taxa:

1. *A conservation dependent* taxon is the focus of continuing taxon specific or habitat specific conservation programmes. The cessation of these programmes would result in the taxon qualifying for one of the threatened categories within five years
2. *A near threatened* taxon does not qualify as being *conservation dependent* but it is close to being of vulnerable status.
3. *A least concern* taxon does not qualify as being *conservation dependent* or *near threatened*.

### **Data deficient**

This is when there is insufficient information to assess the risk of extinction for a particular taxon.

## Appendix 2: The Criteria used by the Department of Conservation to Determine its Threatened Species Conservation Work

(from Tisdall, 1994, Molloy & Davis, 1992)

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|---|--|
| <p><b>DISTINCTIVENESS</b></p> <p>A. TAXONOMIC DISTINCTIVENESS:</p> <p>5 Only one family in the order, or one genus in the family</p> <p>4 Only one species within the genus</p> <p>3 Recognised at species level; genetically and/or morphologically highly distinct from other members of the genus</p> <p>2 Recognised at species level; morphologically and genetically quite similar to related species</p> <p>1 Recognised at subspecies level</p> <p>Note: Select the highest score that applies to each case</p>   | <p>C. LARGEST POPULATION:</p> <p><b>Vertebrates, except Reptiles, Amphibians, and Fish:</b></p> <p>5 Less than 50</p> <p>4 From 50 to 100, or unknown but suspected to be small</p> <p>3 From 100 to 500</p> <p>2 From 500 to 1000</p> <p>1 More than 1000, or unknown but suspected to be large</p> <p><b>Invertebrates, Reptiles, Amphibians, and Fish:</b></p> <p>5 Less than 50, or area &lt;0.25 ha</p> <p>4 From 50 to 100, or area 0.25 ha, or unknown but suspected to be small</p> <p>3 From 100 to 500, or area 1-10 ha</p> <p>2 From 500 to 1000, or area 10-100 ha</p> <p>1 More than 1000, or area &gt;100 ha, or unknown but suspected to be large</p> <p><b>Plants:</b></p> <p>5 One plant or area &lt;1 sq m</p> <p>4 From 2 to 10 plants, or area 1-10 sq m, or unknown but suspected to be small</p> <p>3 From 11 to 50 plants, or area 10-100 sq m</p> <p>2 From 50 to 500 plants, or area 100-1000 sq m</p> <p>1 Greater than 500 plants, or area &gt;1000 sq m, or unknown but suspected to be large</p>                    |
| <p><b>STATUS</b></p> <p>A. NUMBER OF POPULATIONS:</p> <p>5 Only one known</p> <p>4 Only two known</p> <p>3 From 3 to 4 known, or unknown but suspected to be small</p> <p>2 From 5 to 10 known</p> <p>1 More than 10 known, or unknown but suspected to be large</p> <p>B. MEAN POPULATION SIZE:</p> <p><b>Vertebrates, except Reptiles, Amphibians, and Fish:</b></p> <p>5 Less than 50</p> <p>4 From 50 to 100, or unknown but suspected to be small</p> <p>3 From 100 to 500</p> <p>2 From 500 to 1000</p> <p>1 More than 1000, or unknown but suspected to be large</p> <p><b>Vertebrates, except Reptiles, Amphibians, and Fish:</b></p> <p>5 Less than 50, or area &lt;0.25 ha</p> <p>4 From 50 to 100, or area 0.25-1 ha, or unknown but suspected to be small</p> <p>3 From 100 to 500, or area 1-10 ha</p> <p>2 From 500 to 1000, or area 10 to 100 ha</p> <p>1 More than 1000, or area &gt;100 ha, or unknown but suspected to be large</p> <p><b>Plants:</b></p> <p>5 One plant or area &lt;1 sq m</p> <p>4 From 2 to 10 plants, or area 1-10 sq m, or unknown but suspected to be small</p> <p>3 From 11 to 50 plants, or area 10 to 100 sq m</p> <p>2 From 50 to 500 plants, or area 100-1000 sq m</p> <p>1 Greater than 500 plants, or area &gt;1000 sq m, or unknown but suspected to be large</p> | <p>D. GEOGRAPHIC DISTRIBUTION:</p> <p>5 Total range &lt;10km<sup>2</sup></p> <p>4 Found only in single ecological district</p> <p>3 Found only in either North or South Island, or either two or three ecological districts</p> <p>2 Found only in New Zealand</p> <p>1 Occurs outside New Zealand</p> <p>E. CONDITION OF LARGEST POPULATION:</p> <p>5 Very poor</p> <p>4 poor</p> <p>3 Marginal</p> <p>2 Moderate</p> <p>1 Healthy</p> <p>F. POPULATION DECLINE RATE:</p> <p>5 Total wild population presently declining at a rate which is likely to cause the taxon to become extinct in the short-term (10-15 years)</p> <p>4 Total wild population presently declining at a rate which is likely to cause the taxon to become extinct in the medium-term (15-25 years), or unknown but suspected to be declining rapidly</p> <p>3 Total wild population presently declining at a rate which is like to cause the taxon to become extinct in the longer-term (25-50 years), or unknown but suspected to be declining at a moderate rate.</p> |

|  |   |
|--|---|
| <p>2 Total wild population presently showing very slight decline which is not expected to threaten the survival of the taxon in the next 50 years</p> <p>1 total wild population stable or increasing</p>  | <p><b>VULNERABILITY</b></p>   |
| <p><b>THREATS</b></p>  | <p>A. HABITAT AND/OR DIET SPECIFICITY:</p> <p>5 Displays extreme habitat and/or diet specificity</p> <p>4 Displays high habitat and/or diet specificity</p> <p>3 Displays moderate habitat and/or diet specificity</p> <p>2 Displays slight habitat and/or diet specificity</p> <p>1 Displays characteristics of a generalist</p> <p>B. REPRODUCTIVE AND/OR BEHAVIORAL SPECIALISATION:</p> <p>5 Displays reproductive and/or behavioral specialisations which severely limit the recovery ability of the taxon</p> <p>4 Displays reproductive and/or behavioral specialisations which has a high impact on the recovery ability of the taxon</p> <p>3 Displays reproductive and/or behavioral specialisations which have a moderate impact on the recovery ability of the taxon</p> <p>2 Displays reproductive and/or behavioral specialisations which only limit the recovery ability of the taxon</p> <p>1 Displays no reproductive and/or behavioral specialisations which severely limit the recovery ability of the taxon</p> <p>C. CULTIVATION/CAPTIVE BREEDING:</p> <p>5 Not known to be in captivity/cultivation or germ plasm bank, and/or breeding in captivity/propagation unsuccessfully</p> <p>4 Rarely in captivity/cultivation (not in germ plasm bank), and/or breeding in captivity/propagation not well documented or often unsuccessful and many require highly specialised techniques</p> <p>3 Occasional to frequent in captivity/cultivation, and/or breeding success in captivity/propagation variable. Includes taxa which, while easy to propagate asexually, are difficult to propagate sexually</p> <p>2 Occasional to frequent in captivity/cultivation, and/or breeding in captivity/propagation occurs regularly</p> <p>1 Widely bred/grown in documented collections</p> |
| <p>A. LEGAL PROTECTION OF HABITAT:</p> <p>5 No legal protection of any site</p> <p>4 Informal protection at one or several sites</p> <p>3 Long-term legal protection for at least one site</p> <p>2 Long-term legal protection for several sites</p> <p>1 Long-term legal protection at most or all sites</p> <p>B. HABITAT LOSS RATE:</p> <p>5 All remaining breeding grounds/occupied habitat likely to be destroyed in less than 10 years</p> <p>4 Over half of the remaining breeding grounds/occupied habitat likely to be destroyed in less than 10 years</p> <p>3 Between 25 and 50% of the remaining breeding grounds/occupied habitat likely to be destroyed in less than 10 years</p> <p>2 Between 10 and 25% of the remaining breeding grounds/occupied habitat likely to be destroyed in less than 10 years</p> <p>1 Less than 10% of the remaining breeding grounds/occupied habitat likely to be destroyed in the next 10 years</p> <p>C. PREDATOR/HARVEST IMPACT:</p> <p>5 Predation/harvest having severe impact on the survival of the taxon</p> <p>4 Predation/harvest having high impact on the survival of the taxon; or impact unknown but suspected to be high</p> <p>3 Predation/harvest having moderate impact on the survival of the taxon</p> <p>2 Light predation/harvest with little impact, or impact unknown but suspected to be slight</p> <p>1 Predation/harvest insignificant</p> <p>D. COMPETITION:</p> <p>5 Competition having severe impact on the survival of the taxon</p> <p>4 Competition having considerable impact on the survival of the taxon, or impact unknown but suspected to be high</p> <p>3 Competition having moderate impact on the survival of the taxon</p> <p>2 Competition having slight impact, or impact unknown but suspected to be slight</p> <p>1 Competition insignificant</p> <p>E. OTHER FACTORS AFFECTING SURVIVAL:</p> <p>5 Other factor(s) exist which are severely affecting the survival of the taxon</p> <p>4 Other factor(s) exist which are having a considerable impact on the survival of the taxon</p> <p>3 Other factor(s) exist which are having a moderate impact on the survival of the taxon</p> <p>2 Other factor(s) exist which are having a slight impact on the survival of the taxon</p> <p>1 No other factors known</p> | <p><b>VALUES</b></p> <p>A. MAORI CULTURAL VALUES:</p> <p>4 Extremely important for one or more iwi</p> <p>3 Moderate-high importance for one or more iwi</p> <p>2 Low-moderate importance for one or more iwi</p> <p>1 Minor significance</p> <p>B. PAKEHA CULTURAL VALUES:</p> <p>4 Regarded as important by virtually all people</p> <p>3 Regarded as important by the majority of people</p> <p>2 Regarded as important by a moderate number of people</p> <p>1 Regarded as important by a few people</p>  |

