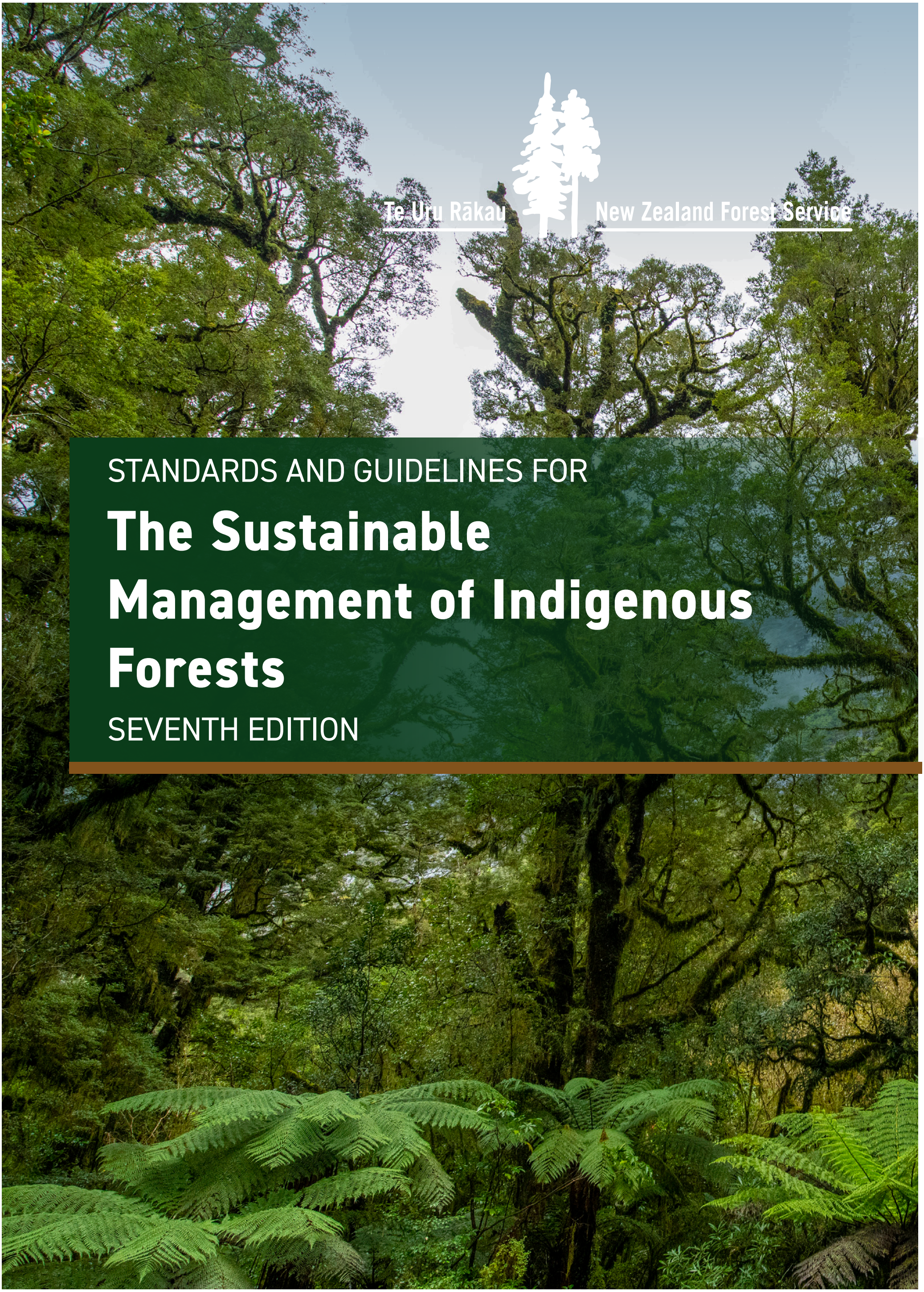

Te Uru Rākau — New Zealand Forest Service

STANDARDS AND GUIDELINES FOR

The Sustainable Management of Indigenous Forests

SEVENTH EDITION

Te Kāwanatanga o Aotearoa
New Zealand Government

August 2024

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FOREWORD

This is the seventh edition of the *Standards and Guidelines for the Sustainable Management of Indigenous Forests.*

The standards and guidelines will continue to provide the framework against which sustainable forest management plans and permits and their implementation will be tested, and technical guidelines for sustainable management of indigenous forests.

They are also a valuable reference tool for:

- forest owners and managers;
- resource planners; and
- policy analysts.

CONTENTS

PREAMBLE

PURPOSE AND SCOPE

Landowners and forest managers seeking approvals for Sustainable Forest Management (SFM) Plans and Permits must comply with the Indigenous Forestry Provisions (Part 3A) of the Forests Act 1949 (the Forests Act). The Forests Act is administered by the Ministry for Primary Industries (MPI).

Before MPI formulated these standards and guidelines for sustainable management of indigenous forests, standards were interpreted directly from the Forests Act. In some areas the Forests Act provides explicit, quantifiable performance standards, but in other areas the Act is not specific.

MPI standards and guidelines material for sustainable management of New Zealand's privately owned indigenous forests reflect the statutory requirements under Part 3A of the Forests Act, and specify structured indigenous forestry standards for approval and administration of SFM Plans and Permits. Each criterion and its subset of goals, indicators and standards provides guidance on how MPI applies provisions of the Forests Act.

The objective of the MPI standards and guidelines material is to present procedures and practice standards for sustainable forest management. In pursuit of this objective, the MPI standards and guidelines provide landowners and forest managers with:

› recommended procedures and required steps to follow to achieve requirements under the Forests Act;

- standards set for specific requirements under the Forests Act;
- a guide to the matters that will be considered by MPI in administering the Forests Act provisions – specifically, approving SFM Permit applications and draft SFM Plans, and providing a basis for monitoring, reporting and reviewing forest management performance.

STANDARD SETTING

Standard setting is an ongoing process and must recognise the following points:

- Standards need to be simple, achievable and assessable.
- Indicators (variables that characterise ecosystem processes and/or management systems) that are measured to determine standards compliance must be responsive to environmental change, easily sampled and functional.
- New Zealand's forests are changing, as a result of both natural and human-induced factors. Establishing appropriate standards reflecting the state of ecosystems and interpreting measured change is therefore an evolving process.
- Information on some standards associated with indicators of SFM does not exist or is rudimentary. Standard parameters will need to be defined and/or refined as ecosystem management and knowledge develops.
- Individual forest areas are subject to unique combinations of physical and biotic factors. Standards must be able to accommodate local values.

In indigenous forests, mixed associations of plant species are generally classified as "forest types", which may include one or more commercial timber tree species. They also reflect the variability and limits of soils and other natural factors. This variability can affect the mix of species and other aspects that have a bearing on management under the Forests Act.

In developing and applying the MPI standards and guidelines material, MPI recognises that the variability of forest types means that draft SFM Plan and SFM Permit applications must be assessed on a case-by-case basis.

However, MPI also recognises the need for verifiable standards (performance measures) based on forestry practice reflecting the overall purpose of the Forests Act, which is:

> To promote the sustainable management of indigenous forest land.

The standards provided under each of the criteria for SFM set limits which will, in all cases to which a given standard applies, be assessed by MPI prior to approval of draft SFM Plans, SFM Permit applications or Annual Logging Plans (as the case may be) and in subsequent monitoring.

MPI's *Standards and Guidelines for the Sustainable Management of Indigenous Forests* also aims to give information about the steps and considerations required in formulating and implementing SFM Plans and Permits while also directing readers to references for additional technical assistance. This document will be subject to periodic review and will be updated when statutory requirements or technical information change.

ADOPTION OF THE STANDARDS

MPI is charged with administering Part 3A of the Forests Act under delegation from the Director-General of MPI (referred to as the "Secretary" in the Forests Act[1]).

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[1] When Part 3A of the Forests Act was introduced in 1993 the head of the Ministry of Forestry was the "Secretary of Forestry". In 1998, the Ministries of Forestry and of Agriculture merged into the Ministry of Agriculture and Forestry, and subsequently to the Ministry for Primary Industries in 2012, the head of this is the Director-General of Primary Industries.

Part 3A has the overall purpose of promoting sustainable management of indigenous forest land. MPI's Indigenous Forestry Team manages the assessment and approvals necessary for SFM Permits, approval of draft SFM Plans, and other provisions of Part 3A, including personal use approvals (Section 67D(3)). MPI's Indigenous Forestry Team also administers provisions under the Forests Act (Section 67D(1)(a-e) and 67D(2)) for the milling of indigenous timber:

- harvested from area/s subject to a registered SFM Plan or SFM Permit;
- harvested from Māori land not subject to the sustainable forest management provisions of the Forests Act; from Crown land administered under the Conservation Act 1987; or from a planted indigenous forest;
- harvested for a public work, or from a mining operation, accessway, water impoundment, or for scientific research;
- first milled before 1 July 1993, or salvaged from land other than indigenous forest land, or that has died or become windthrown through natural causes;
- seized or sold under the Forests Act, Section 67S.

SFM provisions contained within the Forests Act provide the framework for management of indigenous forest under SFM Plans and, in a more limited capacity, SFM Permits.

MPI adopts the standards contained in this document with the purpose of "promoting the sustainable forest management of indigenous forest land". It will use the standards as a reference in exercising the relevant statutory powers and discretions as set out in the standards in relation to SFM Plans and SFM Permits.

This seventh edition of the Standards and Guidelines for Sustainable Management of Indigenous Forests updates references to reflect changes in legislation as well as correcting minor errors. It supersedes previous editions.

INTRODUCTION

THE INDIGENOUS FORESTRY PROVISIONS (PART 3A) OF THE FORESTS ACT 1949 – POLICY DEVELOPMENT

In June 1989 the Government announced its intention to develop a national policy on the management of indigenous forests on public and private land. A public document was released, entitled *A National Policy for Indigenous Forests*, about which over 4000 submissions were received. This process provided the policy framework for the subsequent development of the Forests Act.

The policy framework was based on the following key principles from that document:

› recognition of the rights and obligations of private land owners;
› recognition of the rights and obligations of the Crown to maintain wildlife habitat and to reflect international agreements involving the Crown;
› recognition of the rights and obligations of Māori landowners and the Crown under the Treaty of Waitangi;
› efficiency, cost effectiveness and equity.

In June 1990 the Government announced its intention to introduce legislation prohibiting the removal of produce from indigenous forests unless it complied with an approved Sustainable Forest Management Plan or had the specific approval of the (then) Ministry of Forestry. The Forests Amendment Bill was introduced to Parliament in 1992 and passed in 1993.

The indigenous forestry provisions of the Forests Act inserted by the 1993 amendment apply to more than a million hectares of private indigenous forests that remain available for timber production. The

Forests Act focuses on private forests, promoting the principle of sustainable forest management by allowing a timber harvest at a level that also provides for management of natural (non-timber) values.

The Forests Act requires mills cutting indigenous timber to register, and places restrictions on milling and allowable exports. It included a transitional four-year period of harvesting from 1992–1996 based on mills' pre-legislation cutting levels, so that the industry could adjust to the change in log supply. The Part 3A provisions became fully operative in July 1996.

The Forests Act offers landowners the opportunity to benefit commercially from timber production. However, it also imposes specific restrictions, including explicit prescriptions that cover the management of natural forest species. For landowners who wish to harvest timber, apart from limited volumes under minor provisions, the Forests Act requires the preparation and approval of SFM Plans and Permits.

SUSTAINABLE FOREST MANAGEMENT

The Forests Act recognises the many values of indigenous forests including flora and fauna, soil and water quality protection, and amenity and commercial timber values. It envisages both the maintenance and enhancement of indigenous forest values.

The Forests Act recognises the rights of landowners to obtain an economic return from a privately owned asset, but also identifies their responsibility to maintain a healthy forest and functioning ecosystem. It aims to achieve an appropriate balance between productive use and maintenance of the forests' natural values.

A sustainably managed forest involves modification as a consequence of timber extraction. The Forests Act focuses on providing forest management within acceptable ecological limits so that a healthy functioning forest ecosystem is maintained in perpetuity, both for the nation and as an economic resource for the owner. The move to ecosystem-based management of indigenous forests is a new challenge for landowners and one that must be met if indigenous timber use is to be acceptable to society in the long term.

Sustainable forest management is defined in the Forests Act as:

> The management of an area of indigenous forest land in a way that maintains the ability of the forest growing on that land to continue to provide a full range of products and amenities in perpetuity while retaining the forest's natural values.

The Act defines amenity values as:

> Those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes.

The principles expressed in the Forests Act are consistent with the key elements of international initiatives to which the New Zealand government is a signatory, such as the Montreal Process on Criteria and Indicators of SFM.

The Forests Act principles also complement the wider purpose of sustainable management of natural and physical resources provided for in the Resource Management Act 1991. However, the Forests Act does not specifically consider socio-economic or community issues.

There are many definitions applied internationally to describe SFM, ranging from "good" forest management to "near natural" forest management. The terminology employed often depends on the history of forest use and the degree of "naturalness" of the forest in question. There is a common theme: the management of forests using "silvicultural systems which limit the magnitude of the resulting changes to levels near those that occur naturally in healthy forests" (Indigenous Forest Policy, New Zealand Institute of Forestry, 1998).

Standards and Guidelines for the Sustainable Management of Indigenous Forests is not designed to help owners achieve independent third party forest management certification. However, keeping to these standards will satisfy some of the prerequisites for private forest certification.

LINKING THE FORESTS ACT TO THE STANDARDS AND GUIDELINES

Statements in the body of the Forests Act and in the Second Schedule to the Forests Act further define, in varying detail, what SFM is taken to be under that legislation. Rather than repeat these, this document:

› identifies principles (referred to in this document as criteria) for sustainable forest management embodied in the Forests Act;
› defines goals for the management of indigenous forests so that they are maintained in perpetuity, both as functioning ecosystems and an economic resource[2];
› presents, in a standards framework, a set of broad indicators and performance standards that may be added to on a case-by-case basis to reflect local forest values;
› constitutes MPI standards for sustainable management of indigenous forests;
› provides background information and guidance to landowners on appropriate forest management practice and where to obtain more information.

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[2] See the *Guide to the Associated Roles of the Ministry of Agriculture and Forestry and the Department of Conservation Under Part 3A of the Forests Act, 1949* – November 2000

STRUCTURE OF THE STANDARDS AND GUIDELINES

A criterion is defined as a "group of conditions or processes by which sustainable forest management may be assessed" and "characterised by a set of related indicators which are monitored periodically to assess change" (from the *Santiago Statement on Criteria and Indicators, Montreal Process,* 1995).

Under each criterion, the "conditions" or "processes" are defined as one or more individual management goals, each reflected by one or more indicators. Achievement of each goal is assessed through the setting and auditing of specific performance standards, tailored to the individual forest.

The criteria have their basis in the stated purpose of Part 3A of the Forests Act, the definition of sustainable forest management contained in that Act, and specific clauses that identify key outcomes required as a result of managing indigenous forests. Criterion 1 reflects the means by which the Forests Act intends sustainable forest management is to be achieved; through the implementation of approved and registered SFM Plans and SFM Permits.

MPI's *Standards and Guidelines for the Sustainable Management of Indigenous Forests* is structured around the individually numbered criteria (each a key principle to SFM) and comprises two parts: the standards, and explanatory material.

Each criterion is accompanied by a set of one or more specific and detailed goals, indicators, and measurable or assessable standards that in turn reflect the purpose of, and subsections within, the Forests Act. These goals, indicators and standards are also individually numbered in line with the criterion under which each is applicable.

All criteria apply to both SFM Plans and Permits, but there are variations in applicability of goals, indicators and, in particular, the standards, between the two management regimes that reflect the different requirements of the Forests Act for SFM Plans and SFM Permits.

PART 1: THE STANDARDS

The complete sets of standards under each criterion form Part 1 of this document. They are listed beneath the goals and indicators they apply to, and in two separate sets. One set is specific to management under SFM Plans, and the other is specific to management under SFM Permits. Each standards set is presented in a separate, labelled column.

These standards reflect and interpret provisions of Part 3A of the Forests Act. In cases where the Forests Act is less than specific, the precise requirement or standard to be met has been set on the basis of what MPI considers to be the minimum required to achieve sustainable forest management, consistent with the purpose of Part 3A. MPI will apply the standards in administering SFM Plans and SFM Permits; that is to say, the limits set in a given standard will, in all cases to which the standard applies, be assessed by MPI before it approves SFM Plans and SFM Permits or Annual Logging Plans, and in subsequent monitoring.

Appendix 3 presents tables linking the standards to the provisions of the Forests Act.

The provisions of the Forests Act, Part 3A, Section 67D are specific to control of sawmills, milling of indigenous timber (including tree ferns) and approval of harvesting and milling indigenous timber for an owner's personal use up to a prescribed volume limit within a prescribed time limit.

The minor sawmilling provisions for which the Director-General of Primary Industries may issue written statements as to his/her satisfaction with respect to compliance, or which the Director-General of Primary Industries may approve under Section 67D, relate to specific, occasional situations. This is in contrast to the long-term planning, monitoring and achievement of pre-defined ecological outcomes necessary to achieve sustainable forest management of indigenous forest land.

For any proposed activity or activities to which Clauses 1–3 of Section 67D pertain, MPI will apply the provisions of Part 3A, Section 67D as written in the Forests Act as the administrative standard. This document does not repeat Section 67D.

PART 2: EXPLANATORY AND GUIDELINE MATERIAL

To help landowners decide on and carry out management practices in key areas prerequisite to SFM, Part 2 of this document contains, under each of the criterion, explanatory information and guidelines on what needs to be done and how it should be done, consistent with principles of SFM. Where goals and indicators for management under SFM Plans or SFM Permits are different, separately worded goals and/or indicators are shown and identified.

Text following from criteria, goals and indicators, and preceding one or more standards (location of each standard in Part 2 is shown by its number) may contain material on the rationale and background to the goals or indicators. It is the explanatory or guidance material pertinent to the standard(s) it has preceded. In addition, each standard number is accompanied by a brief statement that indicates how it relates to the explanatory material that went before.

The material in Part 2 is not intended to be a comprehensive treatment of every SFM practice for every situation. Specific sets of circumstances may require further research or consultation to determine the most appropriate management practice for achieving the SFM outcome desired. References are provided in Part 2 and are listed at the end of this document. Some of these may not be readily accessible to the public. MPI will provide relevant background information to landowners on request, where it is available.

PART 1

THE STANDARDS

CRITERION 1

MANAGE INDIGENOUS FORESTS IN ACCORDANCE WITH APPROVED AND REGISTERED SUSTAINABLE FOREST MANAGEMENT (SFM) PLANS AND PERMITS

SFM PLANS

GOAL 1.1: DRAFT SFM PLANS SUBMITTED FOR APPROVAL ADDRESS THE MATTERS SET OUT IN PART 3A AND THE SECOND SCHEDULE TO THE FORESTS ACT 1949

INDICATOR 1.1.1
Compliance with Part 3A and the Second Schedule to the Forests Act

STANDARD 1.1.1.1

SFM Plans shall include the following information:

1. Land description and tenure

(should be accompanied by copies of current Certificates of Title (where issued) and plans). Ownership, or the right to harvest indigenous timber from the forest, shall be clearly established. In the case of Māori land where legal title may not be

SFM PERMITS

GOAL 1.1: SFM PERMIT APPLICATIONS SUBMITTED FOR APPROVAL ADDRESS THE MATTERS SET OUT IN PART 3A AND THE SECOND SCHEDULE TO THE FORESTS ACT 1949

INDICATOR 1.1.1
Compliance with Part 3A and the Second Schedule to the Forests Act

STANDARD 1.1.1.1

SFM Permit Applications shall include the following information:

1. Land description including current copies of relevant Certificate(s) of Title where issued. Ownership, or the right to harvest indigenous timber from the forest, shall be clearly established. In the case of Māori land where legal title may not be

SFM PLANS	SFM PERMITS
available, documents (for example Trust Deeds) establishing the rights of the trustees to make decisions regarding management of the forest on behalf of the owners shall be available. A group of owners of a number of landholdings may submit a draft SFM Plan for their forests.	available, documents (for example Trust Deeds) establishing the rights of the trustees to make decisions regarding management of the forest on behalf of the owners shall be available. 2. The full name and physical address of the owners of the landholding or landholdings (applicants).
2. The full names and physical addresses of the owners of the landholding or landholdings (applicants). 3. Forest description, including a description and maps showing forest types and sites of previous logging. 4. Relevant requirements under the applicable District and Regional Plans. 5. The term for which the plan will be in force. 6. Forest inventory information on:	3. A description of the forest including a map showing the forest area covered by the application. 4. An estimate of the timber resource present on the forest area, by species (an inventory by the landowner is not mandatory, but MPI may elect to undertake such forest appraisal or inventory as deemed necessary to adequately describe the forest and check/obtain volume estimates).
› the names and species of timber and tree ferns to be harvested; › details of the proposed volume of timber to be harvested;	6. Prescriptions for the protection of the forest from pests, stock, fire and other threats. 7. Measures to be taken to retain (and where appropriate

SFM PLANS	SFM PERMITS
› forest inventory information to justify the proposed levels (rates) of harvest. 7. Forest management and monitoring prescriptions. 8. Prescriptions for the protection of the forest from pests, stock, fire and other threats. 9. Measures to be taken to retain (and where appropriate enhance) flora and fauna and soil and water quality.	enhance) flora and fauna and soil and water quality.

CRITERION 2

RETAIN AND ENHANCE NATURAL VALUES

SFM PLANS

GOAL 2.1: SILVICULTURAL SYSTEMS EMPLOYED RETAIN THE FOREST'S NATURAL VALUES

INDICATOR 2.1.1
Flora and fauna species

STANDARD 2.1.1.1
Flora and fauna species and assemblages are maintained.

INDICATOR 2.1.2
Presence of old, large trees with high habitat values

STANDARD 2.1.2.1
A proportion of old trees with high habitat values shall be identified and retained to undergo natural mortality processes. Numbers to be retained (by species) will be determined on the basis of forest type, structure and flora and fauna present, and may be specified in conditions attached to approved Annual Logging Plans.

SFM PERMITS

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SFM PLANS

STANDARD 2.1.2.2

A proportion of trees across all size classes shall be retained to complete their growth cycle and maintain a representation of old trees with high habitat values within the forest.

INDICATOR 2.1.3

Stand composition, structure, regenerative patterns and growth

STANDARD 2.1.3.1

Stand composition and structure shall, as far as possible, be maintained consistent with unmanaged forest except where beech and other light-demanding species are managed in coupes.

INDICATOR 2.1.4

Forest margins, wetlands and natural clearings

STANDARD 2.1.4.1

Harvesting close to forest margins (within 20 metres) is restricted to single trees and small groups, to maintain natural values associated with forest margins, wetlands and natural clearings.

SFM PERMITS

STANDARD 2.1.2.2

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SFM PLANS

GOAL 2.2: SILVICULTURAL PRACTICES MEET SECOND SCHEDULE PRESCRIPTIONS

INDICATOR 2.2.1
Harvest selection intensity and distribution

STANDARD 2.2.1.1
Harvesting of kauri and podocarp species shall be confined to single trees or groups of up to three to five trees.

STANDARD 2.2.1.2
Kauri and podocarp species shall be harvested using low-impact techniques.

STANDARD 2.2.1.3
Where ground-based harvesting of kauri and podocarp species is to be undertaken, temporary access tracks established should:

- avoid damage to valuable tree stocks and minimise damage to other vegetation;
- be sited on well drained topography;
- minimise formation work (cutting, filling, side-casting);

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SFM PLANS

- limit the need for machines to move off the tracks to undertake timber extraction.

STANDARD 2.2.1.4

On steep slopes (generally regarded as over 25°) and on poorly drained soils, landowners shall use helicopters where necessary to protect soils and maintain water quality for harvesting kauri and podocarp species. Rules in Regional and District Plans may determine slope limits for ground-based forest operations.

STANDARD 2.2.1.5

Pre-harvest assessment of the forest shall be undertaken, and trees selected for harvest in the first instance shall be those that:

- are showing advanced signs of crown dieback;
- have sustained major damage to their crowns or stems from natural or other causes;
- have sustained major damage to their root systems likely to affect their health or stability;

SFM PERMITS

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SFM PLANS

› have major stem rots likely to affect their health or stability.

STANDARD 2.2.1.6

Harvesting shall be restricted, as far as possible, to the selective removal of trees predisposed to windthrow or early death, providing that a proportion of trees are retained to undergo natural processes and provide habitat for flora and fauna.

STANDARD 2.2.1.7

Harvesting of shade-tolerant and exposure-sensitive broadleaved hardwood species shall be confined to single trees or groups of up to three to five trees.

STANDARD 2.2.1.8

Shade-tolerant and exposure-sensitive broadleaved hardwood species shall be harvested using low-impact techniques.

STANDARD 2.2.1.9

Where ground based harvesting of shade-tolerant and exposure-sensitive broadleaved hardwood species is to be undertaken

SFM PERMITS

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SFM PLANS

temporary access tracks established should:

- avoid damage to valuable tree stocks and minimise damage to other vegetation;
- be sited on well drained topography;
- minimise formation work (cutting, filling, side-casting);
- limit the need for machines to move off the tracks to undertake timber extraction.

STANDARD 2.2.1.10

In harvesting shade-tolerant and exposure-sensitive broadleaved hardwood species, gap creation shall take natural regeneration processes into account.

STANDARD 2.2.1.11

The maximum beech coupe size shall generally be 0.5 hectares.

STANDARD 2.2.1.12

MPI may elect to decline an application for the harvesting of beech coupes larger than 0.5 hectares and less than 20 hectares, if such harvesting would result in:

SFM PERMITS

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SFM PLANS

- a significant adverse impact on flora, fauna or other natural values;
- a significant increase in soil erosion or in the risk of soil erosion;
- a significant adverse impact on drainage or aquatic ecosystems;
- a significant impact on indigenous forest regeneration;
- a significant adverse impact on the amenity values of the forest.

STANDARD 2.2.1.13

Before harvesting any coupe within a distance from a harvested coupe equal to the width of the harvested coupe, regeneration on the harvested coupe must have reached a predominant mean height of 4 metres and have reached a stocking of the harvested species equal to or greater than the forest before harvesting.

SFM PERMITS

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SFM PLANS

INDICATOR 2.2.2

Restocking of harvested kauri, podocarps and shade-tolerant or exposure-sensitive broadleaved hardwood species

STANDARD 2.2.2.1

Where advanced growth is insufficient to replace harvested stems, nursery-raised seedlings of the same species as harvested shall be planted at the rate of five seedlings, at least 60 centimetres high, per tree harvested.

STANDARD 2.2.2.2

Seedlings or seed collected for this purpose shall be sourced from the ecological district in which the seedlings are to be planted. (Species can exhibit local variation and have distinct physical traits that may be genetically controlled.)

INDICATOR 2.2.3

Restocking of harvested beech and light-demanding species

STANDARD 2.2.3.1

If regeneration is lacking five years after harvest, planting of

SFM PERMITS

INDICATOR 2.2.2

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SFM PLANS	SFM PERMITS
seedlings shall be undertaken, accompanied by site preparation as required to provide seedlings with competition-free sites.	seedlings shall be undertaken, accompanied by site preparation as required to provide seedlings with competition-free sites.
STANDARD 2.2.3.2 Planting density, coupled with natural regeneration, should be no less than about 500 sph but will be determined on the basis of initial inventory information or subsequent forest inspection.	**STANDARD 2.2.3.2** Planting density, coupled with natural regeneration, should be no less than about 500 sph but will be determined on the basis of initial forest appraisal/ description information or subsequent forest inspection.
STANDARD 2.2.3.3 Beech species seedlings or seed collected for this purpose shall be sourced from the ecological district in which the seedlings are to be planted. (Species can exhibit local variation and have distinct physical traits that may be genetically controlled.)	**STANDARD 2.2.3.3** Beech species seedlings or seed collected for this purpose shall be sourced from the ecological district in which the seedlings are to be planted. (Species can exhibit local variation and have distinct physical traits that may be genetically controlled.)

SFM PLANS

GOAL 2.3: REPRESENTATIVE AREAS ARE SET ASIDE TO PROTECT EXAMPLES OF FOREST

INDICATOR 2.3.1

Identification of forest types/habitats not well represented in protected areas

STANDARD 2.3.1.1

Representative areas not exceeding 20 percent of the total forest area to which the SFM Plan relates shall either:

1. be of an adequate size and location to be accurately representative and adequately protective of such flora, fauna and other conservation values in the region concerned; or
2. provide adequate protection for the flora, fauna and other conservation values in the representative area together with any indigenous forest land protected under any Act in the region concerned.

STANDARD 2.3.1.2

Harvesting shall not be undertaken in a representative area.

SFM PERMITS

GOAL 2.3: REPRESENTATIVE AREAS ARE SET ASIDE TO PROTECT EXAMPLES OF FOREST

INDICATOR 2.3.1

Identification of forest types/habitats not well represented in protected areas

STANDARD 2.3.1.1

Representative areas not exceeding 20 percent of the total forest area to which the SFM Permit relates shall either:

1. be of an adequate size and location to be accurately representative and adequately protective of such flora, fauna and other conservation values in the region concerned; or
2. provide adequate protection for the flora, fauna and other conservation values in the representative area together with any indigenous forest land protected under any Act in the region concerned.

STANDARD 2.3.1.2

Harvesting shall not be undertaken in a representative area.

SFM PLANS

STANDARD 2.3.1.3

Where a representative area is set aside, a map clearly showing the boundaries of the area(s) shall be attached to the registered SFM Plan.

GOAL 2.4: THE SUITE OF INDIGENOUS SPECIES PRESENT IN THE FOREST IS MAINTAINED

INDICATOR 2.4.1

Selected indicator species remain at expected levels of abundance

STANDARD 2.4.1.1

Native animal (including invertebrates, which may be among the most effective indicators of maintenance of natural values) and plant species' populations/presence, as indicated by selected indicator species, shall remain comparable with similar unmanaged forest.

STANDARD 2.4.1.2

Where threatened flora or fauna species are present in the forest, appropriate prescriptions for their protection are to be incorporated in an approved SFM Plan.

SFM PERMITS

STANDARD 2.3.1.3

Where a representative area is set aside, a map clearly showing the boundaries of the area(s) shall be attached to the registered SFM Permit.

GOAL 2.4: THE SUITE OF INDIGENOUS SPECIES PRESENT IN THE FOREST IS MAINTAINED

INDICATOR 2.4.1

Selected indicator species remain at expected levels of abundance

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Native animal (including invertebrates, which may be among the most effective indicators of maintenance of natural values) and plant species' populations/presence, as indicated by selected indicator species, shall remain comparable with similar unmanaged forest.

STANDARD 2.4.1.2

Where threatened flora or fauna species are present in the forest, appropriate prescriptions for their protection shall be incorporated in an approved SFM Permit.

SFM PLANS	SFM PERMITS
STANDARD 2.4.1.3 In applying prescriptions/ conditions for the protection of flora and fauna, MPI must have regard to recommendations of DOC.	**STANDARD 2.4.1.3** In applying prescriptions/ conditions for the protection of flora and fauna, MPI shall have regard to recommendations of DOC.
INDICATOR 2.4.2 **Stand composition and structure does not reflect comparable unmanaged forest nearby**	**INDICATOR 2.4.2** **Not applicable**
STANDARD 2.4.2.1 Forest modified by logging or other practices shall be managed so as to enable forest composition and structure to return to a near-natural state over time.	**STANDARD 2.4.2.1** Not applicable
INDICATOR 2.4.3 **Silvicultural tending**	**INDICATOR 2.4.3** **Not applicable**
STANDARD 2.4.3.1 Where tending is proposed for all or selected stands in the forest, the silvicultural regimes shall be fully described in SFM Plans and must promote forest composition, structure and stocking consistent with natural patterns.	**STANDARD 2.4.3.1** Not applicable

CRITERION 3

MAINTAIN THE ABILITY OF THE FOREST TO PROVIDE NON-DIMINISHING HARVESTS

SFM PLANS

GOAL 3.1: RESOURCE INFORMATION IS SUFFICIENT IN COVERAGE, ACCURACY AND PRECISION

INDICATOR 3.1.1

Inventory of volume, density and size class by forest type and species

STANDARD 3.1.1.1

The names (and species) of timber trees and tree ferns proposed to be harvested shall be identified, and inventory information presented must be sufficient to justify the level of harvest proposed by the owner.

STANDARD 3.1.1.2

Forest description, using the forest reconnaissance or other suitable method, shall be undertaken in conjunction with the inventory of timber resources, to provide a qualitative assessment of the

SFM PERMITS

GOAL 3.1: RESOURCE INFORMATION IS SUFFICIENT

INDICATOR 3.1.1

Appraisal of volume and species (estimate only, required of volume by species)

STANDARD 3.1.1.1

The names (and species) of timber trees and tree ferns proposed to be harvested shall be identified.

STANDARD 3.1.1.2

Forest description, using the forest reconnaissance or other suitable method, shall be undertaken to provide a qualitative assessment of the forest and permit the resultant forest types to be related to

SFM PLANS	SFM PERMITS
forest and allow the resultant forest types to be related to broad environmental patterns including disturbance histories. Forest description shall include a list of observed fauna species and flora species present within height tiers. It shall also note dominant species and site characteristics including slope, aspect, drainage, and signs of animal impacts.	broad environmental patterns including disturbance histories. Forest description shall include a list of observed fauna species and flora species, and site characteristics including slope, aspect, drainage, and signs of animal impacts.
STANDARD 3.1.1.3 Forest assessment covers non-commercial and commercial tree species.	**STANDARD 3.1.1.3** Forest assessment is largely confined to commercial tree species.
STANDARD 3.1.1.4 The minimum timber measurements required, by species, are diameter at breast height (dbh 1.4 metres above ground level) with deduction as appropriate for visible abnormality (excessive butt swell, fluting/flanging) that renders any section of a tree bole (or toplog) not capable of being milled, the height of the main stem of the tree to a predetermined top diameter	**STANDARD 3.1.1.4** The minimum timber measurements required, by species, are diameter at breast height (dbh 1.4 metres above ground level) with deduction as appropriate for visible abnormality (excessive butt swell, fluting/flanging) that renders any section of a tree bole (or toplog) not capable of being milled, the height of the main stem of the tree to a predetermined top diameter

SFM PLANS	SFM PERMITS
(usually 15 centimetres, or the point at which the main stem branches into the crown), and estimates of centre girth diameter and length of any toplogs.	(usually 15 centimetres, or the point at which the main stem branches into the crown), and estimates of centre girth diameter and length of any toplogs.
STANDARD 3.1.1.5 Size class distributions shall be tabulated that indicate the density of stems within predetermined diameter classes.	**STANDARD 3.1.1.5** Not applicable
STANDARD 3.1.1.6 Inventory and data presentation shall also include regeneration and advanced growth (density per hectare of seedlings, saplings and poles within size classes) for all species proposed to be managed.	**STANDARD 3.1.1.6** Forest appraisal data shall include estimates of regeneration and advanced growth (density per hectare of seedlings, saplings and poles within size classes) for all species proposed to be managed. These data can be obtained by MPI using suitable low intensity bounded plot inventory procedures where information included in an SFM Permit application is deemed insufficient.

SFM PLANS

STANDARD 3.1.1.7

Volume, by species, on a per hectare basis and for the forest area, is a necessary output of inventory. Standing volume is the legal basis for describing the timber resource and the allowable harvest. The Forests Act is not specific as to timber quality, so the *total* volume present of merchantable dimension, based on external measurement, for each species proposed to be harvested, is the minimum essential output of forest inventory.

STANDARD 3.1.1.8

The inventory method shall be described in draft SFM Plans, including the specific rules adopted for measurement (e.g. minimum tree/log size specifications). Where volume is described in log quality classes, rules for differentiating those log quality classes shall also be included.

SFM PERMITS

STANDARD 3.1.1.7

Volume, by species, and for the forest area, is a necessary output of forest appraisal and description. Standing volume is the legal basis for describing the timber resource and the allowable harvest. The Forests Act is not specific as to timber quality, so the *total* volume present of merchantable dimension, based on external measurement, for each species proposed to be harvested, is the minimum essential output of forest appraisal and description.

STANDARD 3.1.1.8

Where forest appraisal to confirm SFM Permit volume assessment and/or forest description is undertaken by MPI this will be by low intensity inventory by:

1. aerial counting of emergent species, supported by a sample of measurements of dbh and height; or
2. a number of sample transects or bounded plots (typically of area between 0.05 and 0.1 hectare per sample unit,

SFM PLANS	SFM PERMITS
	sample unit area used being dependent on forest type and species composition, but consistent within forest type once decided) for species that cannot be accurately counted (trees measured in these sample units include those of the species proposed for harvest and other species as required to sufficiently describe tree species' contribution to stand composition and natural values, e.g. by calculation of basal area of species other than those proposed for harvest); or 3. a combination of the above methods, suitable to, and depending on, the forest type(s) comprising the forest area, with methods used being consistent with any MPI Standard Operating Procedure(s), and being documented in SFM Permit field inspection reporting.

SFM PLANS

INDICATOR 3.1.2
Inventory accuracy and precision

STANDARD 3.1.2.1
Inventory results shall be accompanied by calculated confidence intervals or probable limits of error for estimates of stand density, basal area and volume by species, except where 100 percent enumeration of the commercial species has been undertaken. The results obtained from the inventory shall be sufficiently accurate and precise to justify the sustainable harvest rates proposed for individual species, preferably within probable limits of error of ± 20 percent at 95 percent limits of confidence.

STANDARD 3.1.2.2
Where inventory precision levels for any species fall outside the recommended limits a conservative approach shall be adopted in establishing rates of harvest in keeping with the quality of the inventory information.

SFM PERMITS

INDICATOR 3.1.2
Forest appraisal accuracy and precision

STANDARD 3.1.2.1
Where forest appraisal sample measurements are sufficient to enable calculation of confidence intervals or probable limits of error for estimates of volume by species, these shall be included in forest description.

STANDARD 3.1.2.2
Proposed harvest rates shall be amended where any field assessment by MPI indicates a lesser volume of timber present than estimates contained in a SFM Permit application.

SFM PLANS	SFM PERMITS
INDICATOR 3.1.3 **The rationale provided for proposed harvest rates**	**INDICATOR 3.1.3** **Not applicable**
STANDARD 3.1.3.1 Proposed harvest rates shall be supported by information relating to growth rates for the tree component of the forest.	**STANDARD 3.1.3.1** Not applicable
STANDARD 3.1.3.2 In the absence of detailed growth and modelling data for the forest, and given the likelihood that it will be a minimum of 10 years before data will become available from permanent sample plots, the establishment of initial harvest rates shall be undertaken on the basis of available information and shall be conservative.	**STANDARD 3.1.3.2** Not applicable
GOAL 3.2: HARVESTS DO NOT EXCEED RATES OF SPECIES/ STAND REPLACEMENT	**GOAL 3.2: HARVESTS DO NOT EXCEED RATES OF SPECIES/ STAND REPLACEMENT**
INDICATOR 3.2.1 **Harvest rates by species**	**INDICATOR 3.2.1** **Harvest rates by species**

SFM PLANS	SFM PERMITS
STANDARD 3.2.1.1 Harvest rates proposed in SFM Plans must be specified for individual species and by quality classes where relevant, and collectively for the forest area(s).	**STANDARD 3.2.1.1** The maximum harvests under a SFM Permit for the term of 10 years from date of registration are: › not more than 10 percent of the quantity of each species of indigenous timber (excluding roots) capable of being milled standing on the area of land specified in the permit; and › not more than 250 cubic metres of podocarp or kauri or shade-tolerant, exposure-sensitive broadleaved hardwood species; and › not more than 500 cubic metres of beech or other light-demanding species. A second or subsequent SFM Permit must not be issued in respect of any indigenous timber unless and until the quantity of each species of

SFM PLANS	SFM PERMITS
	indigenous timber (capable of being milled irrespective of its quality, but excluding roots) standing in the area to which the permit will apply is at least equivalent to the quantity of each species standing in the area at the date of the grant of the previous permit. No permit will be granted for an area of indigenous forest land that is specified: › in a SFM Plan as an area of land to which that plan applies; or › in a permit issued within the previous 18 months, as an area to which that permit applies; or › in a permit, registered within the previous ten years, as an area to which that permit applies.

SFM PLANS	SFM PERMITS
STANDARD 3.2.1.2 The length of any felling cycle shall be selected so that the maximum rate of harvest is no more than 5 percent of the stand volume/area for kauri and podocarp and shade-tolerant and exposure-sensitive broadleaved hardwood species managed under selection systems and no more than 10 percent for light-demanding species managed by group/coupe systems (generally only beech). It shall take into account existing stand structure, the ecological requirements of the species under management, and the likely impact on the forest of the management systems being employed. Harvests shall be distributed evenly across the forest compartment or compartments, all other things being equal (forest health, structure, disturbance history).	**STANDARD 3.2.1.2** Not applicable

SFM PLANS

STANDARD 3.2.1.3

Approved sustainable rates of harvest, annual or periodic, shall not be exceeded. Landowners are required to maintain records of harvests undertaken (refer Criterion 7 of these standards and guidelines). These records will be requested by MPI at the completion of annual harvesting.

INDICATOR 3.2.2

Harvest of dead trees and naturally occurring windthrow

STANDARD 3.2.2.1

Allowable harvests shall include the recovery of windthrown and dead trees, as they become available, subject to maintenance of natural values (including stand structure and habitat trees), with the volume of windthrown and dead trees included in the specified allowable harvest. Harvests shall be distributed evenly across the forest or forest compartments, all other things being equal (forest health, structure, disturbance history).

SFM PERMITS

STANDARD 3.2.1.3

Approved sustainable harvests shall not be exceeded. Landowners are required to maintain records of harvests undertaken (refer Criterion 7 of these standards and guidelines). These records will be requested by MPI at the completion of annual harvesting

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SFM PLANS

GOAL 3.3: HARVESTING IS IN ACCORDANCE WITH APPROVED ANNUAL LOGGING PLANS

INDICATOR 3.3.1

Harvest rates by species, harvest location and operational performance

STANDARD 3.3.1.1

Annual Logging Plans shall be submitted for approval by MPI each year a harvest is proposed. They shall be approved prior to work for harvesting timber (including, but not limited to, the felling of timber and the construction of roads, tracks or landings) being undertaken. Annual Logging Plans shall specify the area proposed to be harvested and harvest volumes by species, indicate locations of roads, tracks and landings, both existing and proposed, show waterways, describe topography, specify proposed methods of harvesting and any special logging requirements. MPI may conduct a field inspection of proposed operations (including tree selection) prior to approval of an Annual Logging Plan and/ or of post-operational activities

SFM PERMITS

GOAL 3.3: HARVESTING IS IN ACCORDANCE WITH APPROVED ANNUAL LOGGING PLANS

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SFM PLANS	SFM PERMITS
and harvest sites for compliance with a previously approved Annual Logging Plan.	and harvest sites for compliance with a previously approved Annual Logging Plan.
STANDARD 3.3.1.2	**STANDARD 3.3.1.2**
Harvest volumes shall be specified species by species, on the basis of standing volume (reflecting the inventory specifications). Where industrial or other smallwood forms a significant part of the annual harvest, control may be exercised using scaled weight but shall be converted to standing volume equivalent for reporting purposes.	Harvest volumes shall be specified species by species, on the basis of standing volume reflecting the forest appraisal (or if undertaken, inventory specifications). Where industrial or other smallwood forms a significant part of the annual harvest, control may be exercised using scaled weight but shall be converted to standing volume equivalent for reporting purposes.
STANDARD 3.3.1.3	**STANDARD 3.3.1.3**
MPI may require landowners to specify trees to be harvested or trees to be retained. Trees selected for harvest are marked, measured and recorded by species, prior to harvest.	MPI may require landowners to specify trees to be harvested or trees to be retained. Trees selected for harvest are marked, measured and recorded by species, prior to harvest.
STANDARD 3.3.1.4	**STANDARD 3.3.1.4**
Annual Logging Plans shall be adhered to.	Annual Logging Plans shall be adhered to.

SFM PLANS

GOAL 3.4: SUSTAINABLE FOREST MANAGEMENT PLANS ARE REVIEWED AND AMENDED AS REQUIRED TO ENSURE COMPLIANCE WITH PART 3A OF THE FORESTS ACT

INDICATOR 3.4.1

Effects of major natural events (e.g. windthrow, snow damage, earthquake)

STANDARD 3.4.1.1

SFM Plans shall be amended where forest losses exceed 20 percent of the initial forest appraisal or where significant losses, being less than 20 percent, occur within a specific forest type or area.

INDICATOR 3.4.2

Apparent excessive rates of harvest or residual forest damage or initial growth estimates were too optimistic

STANDARD 3.4.2.1

SFM Plans shall be reviewed where rates of harvest and/or impacts reducing the quantity of timber capable of being harvested and milled exceed the provisions of the SFM Plan.

SFM PERMITS

GOAL 3.4: SUSTAINABLE FOREST MANAGEMENT PERMITS ARE REVIEWED AND AMENDED AS REQUIRED TO ENSURE COMPLIANCE WITH PART 3A OF THE FORESTS ACT

INDICATOR 3.4.1

Effects of major natural events (e.g. windthrow, snow damage, earthquake)

STANDARD 3.4.1.1

SFM Permits shall be amended where forest losses exceed 20 percent of the initial forest appraisal or where significant losses, being less than 20 percent, occur within a specific forest type or area.

INDICATOR 3.4.2

Apparent excessive rates of harvest or residual forest damage

STANDARD 3.4.2.1

SFM Permits shall be reviewed where the harvest of any species exceeds permitted levels but where the full entitlement has not been harvested.

SFM PLANS

STANDARD 3.4.2.2

Where the harvest rate and/or harvesting method(s), combined with natural mortality, compromise the ability of the forest to continue to provide harvests at the approved level, or where inappropriate methods or failure to meet sustainable forest management standards impacts on forest health, amenity or natural values, MPI can:

- require the owner to keep records in a specified manner and use them to control forest operations;
- review and amend, as necessary, management systems, including machinery and methods;
- determine the cause of any apparent overcutting;
- amend harvest rates as necessary;
- in the case of deliberate breaches of the provisions of an approved SFM Plan, apply the penalty provisions of the Forests Act.

SFM PERMITS

STANDARD 3.4.2.2

In the case of deliberate breaches of the provisions of an approved SFM Permit, MPI can apply the penalty provisions of the Forests Act.

SFM PLANS	SFM PERMITS
INDICATOR 3.4.3 **Disruption of forest replacement processes**	**INDICATOR 3.4.3** **Not applicable**
STANDARD 3.4.3.1 SFM Plans shall be reviewed where forest regeneration and recruitment are insufficient to maintain forest structure and approved rates of harvest.	**STANDARD 3.4.3.1** Not applicable
STANDARD 3.4.3.2 Where implementation of forest management systems does not result in forest regeneration, management plan review may be initiated by MPI after an SFM Plan has been in operation for at least five years. Determination of causal factors and amendment to silvicultural systems and/or operational methods shall be undertaken where such a review identifies these as necessary to maintain forest regeneration and growth.	**STANDARD 3.4.3.2** Not applicable
STANDARD 3.4.3.3 Where measured recruitment and growth rates are significantly less (>20 percent) than those used to estimate	**STANDARD 3.4.3.3** Not applicable

SFM PLANS

sustainable rates of harvest, amendment of SFM Plan harvest rates shall be undertaken to ensure long-term sustainability. Conversely, where growth rates and management performance support higher rates of harvest, an SFM Plan may be reviewed at the owner's request.

INDICATOR 3.4.4
Forest management proposals are not economically sustainable

NB. No standard applies under Indicator 3.4.4

SFM PERMITS

INDICATOR 3.4.4
Not applicable

CRITERION 4

RETAIN AND ENHANCE SOIL AND WATER QUALITY

SFM PLANS

GOAL 4.1: IN-FOREST EARTHWORKS (LANDING, ROADING AND TRACKING CONSTRUCTION) DO NOT ADVERSELY AFFECT SOIL AND WATER QUALITY

INDICATOR 4.1.1

Siting and construction of earthworks to minimise forest loss, soil disturbance and maintain water quality

STANDARD 4.1.1.1

SFM Plans shall provide guidelines for establishing access, landings, bridges and fords that reflect the forest's site characteristics and requirements for protecting any marginal strip, and shall specify Regional Plan requirements.

STANDARD 4.1.1.2

Site stability and stream sediment loads shall not be degraded beyond levels that may be fixed by the relevant regional council.

SFM PERMITS

GOAL 4.1: IN-FOREST EARTHWORKS (LANDING, ROADING AND TRACKING CONSTRUCTION) DO NOT ADVERSELY AFFECT SOIL AND WATER QUALITY

INDICATOR 4.1.1

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STANDARD 4.1.1.1

SFM Permits shall provide guidelines for establishing access, landings, bridges and fords that reflect the forest's site characteristics and requirements for protecting any marginal strip.

STANDARD 4.1.1.2

Site stability and stream sediment loads shall not be degraded beyond levels that may be fixed by the relevant regional council.

SFM PLANS

STANDARD 4.1.1.3

Access shall be established some distance (>10–40 metres, depending on site conditions) from permanent streams to avoid the risk of increasing stream sedimentation, and in any event shall be consistent with rules in Regional Plans and requirements for protecting any marginal strip.

GOAL 4.2: FOREST OPERATIONS PROTECT PERMANENT STREAM BEDS AND STREAM AND FOREST MARGINS

INDICATOR 4.2.1

Loss of riparian vegetation, incidence of harvesting debris in streams, damage to forest margins

STANDARD 4.2.1.1

Silviculture, harvesting and extraction close to permanent streams and forest margins are consistent with prescriptions in SFM Plans and in any event shall be consistent with rules in Regional Plans and requirements for protecting any marginal strip.

SFM PERMITS

STANDARD 4.1.1.3

Access shall be established some distance (>10–40 metres, depending on site conditions) from permanent streams to avoid the risk of increasing stream sedimentation, and in any event shall be consistent with rules in Regional Plans and requirements for protecting any marginal strip.

GOAL 4.2: FOREST OPERATIONS PROTECT PERMANENT STREAM BEDS AND STREAM AND FOREST MARGINS

INDICATOR 4.2.1

Loss of riparian vegetation, incidence of harvesting debris in streams, damage to forest margins

STANDARD 4.2.1.1

Silviculture, harvesting and extraction close to permanent streams and forest margins are consistent with prescriptions in SFM Permits and in any event shall be consistent with rules in Regional Plans and requirements for protecting any marginal strip.

SFM PLANS

STANDARD 4.2.1.2

Where permanent streams are present within the forest, SFM Plans shall prescribe for their protection by:

- requiring that trees or parts of trees fallen across or into streams are removed;
- providing for adequate riparian protection zones in keeping with the terrain, soil stability and proposed management systems and in any event shall be consistent with rules in Regional Plans and requirements for protecting any marginal strip.

STANDARD 4.2.1.3

Harvesting undertaken using ground-based machines (for example tracked skidders) shall be limited to an appropriate distance from stream banks. Except where fords are in place this shall be no less than 10 metres and in any event consistent with rules in Regional Plans and requirements for protecting any marginal strip.

SFM PERMITS

STANDARD 4.2.1.2

Where permanent streams are present within the forest, SFM Permits shall prescribe for their protection by:

- requiring that trees or parts of trees fallen across or into streams are removed;
- providing for adequate riparian protection zones in keeping with the terrain, soil stability and proposed management systems and in any event shall be consistent with rules in Regional Plans and requirements for protecting any marginal strip.

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SFM PLANS

GOAL 4.3: FOREST OPERATIONS CAUSE MINIMAL RESIDUAL FOREST DAMAGE, LOSS OF GROUND COVER AND SOIL DEGRADATION

INDICATOR 4.3.1

Ground cover, ponding, soil disturbance and/or compaction and erosive effects of machine use

STANDARD 4.3.1.1

Loss of ground cover, soil disturbance, compaction or erosion due to machine use is, as far as practicable, confined to landings and accessways, except where scarification has been undertaken to encourage beech regeneration in felled coupes.

SFM PERMITS

GOAL 4.3: FOREST OPERATIONS CAUSE MINIMAL RESIDUAL FOREST DAMAGE, LOSS OF GROUND COVER AND SOIL DEGRADATION

INDICATOR 4.3.1

Ground cover, ponding, soil disturbance and/or compaction and erosive effects of machine use

STANDARD 4.3.1.1

Loss of ground cover, soil disturbance, compaction or erosion due to machine use is, as far as practicable, confined to landings and accessways, except where scarification has been undertaken to encourage beech regeneration in felled coupes.

CRITERION 5

MAINTAIN FOREST HEALTH AND PROTECT THE FOREST

SFM PLANS

GOAL 5.1: WEED AND PEST SPECIES ARE CONTROLLED

INDICATOR 5.1.1

Observed presence or spread/increase in populations of weeds and pests

STANDARD 5.1.1.1

SFM Plans shall describe the distribution and population size of weed infestations within the forest. They shall also include prescriptions for inspection and recording of the spread of any weed or pest species, and follow-up control.

STANDARD 5.1.1.2

Where weed infestations occur, regular inspection of harvest sites shall be undertaken to assess levels of forest regeneration/survival and the status of weed populations.

SFM PERMITS

GOAL 5.1: WEED AND PEST SPECIES ARE CONTROLLED

INDICATOR 5.1.1

Observed presence or spread/increase in populations of weeds and pests

STANDARD 5.1.1.1

SFM Permits shall describe the distribution and population size of weed infestations within the forest. They shall also include prescriptions for inspection and recording of the spread of any weed or pest species, and follow-up control.

STANDARD 5.1.1.2

Where weed infestations occur, regular inspection of harvest sites shall be undertaken to assess levels of forest regeneration/survival and the status of weed populations.

SFM PLANS

STANDARD 5.1.1.3

Where impacts of wild animals or pests are evident as deterioration of forest canopy health, lack of forest regeneration or loss of biodiversity, animals and pests shall be actively controlled by shooting or trapping, or poisoning where this is the only practical option.

STANDARD 5.1.1.4

Where adverse impacts of domestic stock are evident, stock shall be prevented from accessing the forest by the erection of temporary or permanent fencing, or other effective means.

GOAL 5.2: FOREST OPERATIONS ARE CONDUCTED SO AS TO MINIMISE RISK OF INCREASED INSECT PEST AND FUNGAL ATTACK

INDICATOR 5.2.1

Signs of insect and fungal attack

STANDARD 5.2.1.1

Silviculture shall be conducted so as to contain forest damage

SFM PERMITS

STANDARD 5.1.1.3

Where impacts of wild animals or pests are evident as deterioration of forest canopy health, lack of forest regeneration or loss of biodiversity, animals and pests shall be actively controlled by shooting or trapping, or poisoning where this is the only practical option.

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Where adverse impacts of domestic stock are evident, stock shall be prevented from accessing the forest by the erection of temporary or permanent fencing, or other effective means.

GOAL 5.2: FOREST OPERATIONS ARE CONDUCTED SO AS TO MINIMISE RISK OF INCREASED INSECT PEST AND FUNGAL ATTACK

INDICATOR 5.2.1

Signs of insect and fungal attack

STANDARD 5.2.1.1

Silviculture shall be conducted so as to contain forest damage

SFM PLANS	SFM PERMITS
by insects and micro-organisms within naturally occurring levels (excluding epidemic events caused by drought, major storms, earthquakes).	by insects and micro-organisms within naturally occurring levels (excluding epidemic events caused by drought, major storms, earthquakes).
STANDARD 5.2.1.2	**STANDARD 5.2.1.2**
Forest damage resulting from silvicultural operations shall be minimised by: › prescribing silvicultural systems suited to forest structure and type; › selecting trees for harvest that can be felled without causing extensive damage to adjacent stems; › adopting directional felling techniques to minimise damage to adjacent stems; › felling trees damaged in the process of conducting silvicultural operations including harvesting, in lieu of other selected trees; › selecting and operating harvest machinery suited to the conditions.	Forest damage resulting from silvicultural operations shall be minimised by: › prescribing silvicultural systems suited to forest structure and type; › selecting trees for harvest that can be felled without causing extensive damage to adjacent stems; › adopting directional felling techniques to minimise damage to adjacent stems; › felling trees damaged in the process of conducting silvicultural operations including harvesting, in lieu of other selected trees; › selecting and operating harvest machinery suited to the conditions.
STANDARD 5.2.1.3	**STANDARD 5.2.1.3**
SFM Plans with a beech forest component shall prescribe	SFM Permits with a beech forest component shall

SFM PLANS	SFM PERMITS
measures to limit brood material for pinhole beetle in the form of stumps or damaged trees whereby: › stumps are trimmed of flanges wherever practicable prior to felling, with felling cuts made as close to ground level as possible; › any tree damaged in harvest activities is felled as a component of the allowable harvest (subject to safety and limiting additional forest damage); › any damaged poles and small trees within a coupe or on a coupe perimeter shall be felled.	prescribe measures to limit brood material for pinhole beetle in the form of stumps or damaged trees whereby: › stumps are trimmed of flanges wherever practicable prior to felling, with felling cuts made as close to ground level as possible; › any tree damaged in harvest activities is felled as a component of the allowable harvest (subject to safety and limiting additional forest damage); › any damaged poles and small trees within a coupe or on a coupe perimeter shall be felled.
STANDARD 5.2.1.4 SFM Plans shall prescribe for: › post-harvest monitoring of pinhole incidence and effect on standing trees at harvest sites, to be undertaken in the second or third year following harvesting; › follow-up harvesting (as determined necessary from monitoring of harvest sites) to recover trees affected	**STANDARD 5.2.1.4** Not applicable

SFM PLANS	SFM PERMITS
by pinhole attack so as to reduce availability of pinhole brood material, subject to any detrimental impacts on the forest from a recovery operation (e.g. to regeneration, soil and water values) being less than that of potential pinhole impact if affected trees were left.	

GOAL 5.3: FOREST OPERATIONS ARE CONDUCTED SO AS TO MINIMISE THE RISK OF FOREST FIRE

INDICATOR 5.3.1
Presence of fire safety rules and equipment

STANDARD 5.3.1.1
Draft SFM Plans shall specify basic fire safety rules and fire equipment.

GOAL 5.3: FOREST OPERATIONS ARE CONDUCTED SO AS TO MINIMISE THE RISK OF FOREST FIRE

INDICATOR 5.3.1
Presence of fire safety rules and equipment

STANDARD 5.3.1.1
SFM Permits may specify protection measures including fire control.

CRITERION 6

MAINTAIN THE FULL RANGE OF AMENITIES

SFM PLANS	SFM PERMITS
GOAL 6.1: CULTURAL AND HISTORIC SITES ARE IDENTIFIED AND, WHERE VULNERABLE, PROTECTED	**GOAL 6.1: CULTURAL AND HISTORIC SITES ARE IDENTIFIED AND, WHERE VULNERABLE, PROTECTED**
INDICATOR 6.1.1 **Specific sites and values**	**INDICATOR 6.1.1** **Specific sites and values**
STANDARD 6.1.1.1 SFM Plans shall include a record of known cultural and historic sites and prescribe for the management/protection of cultural and historic sites	**STANDARD 6.1.1.1** SFM Permit applications shall include a record of known cultural and historic sites and prescribe for the management/protection of cultural and historic sites.
GOAL 6.2: AMENITY VALUES ARE MAINTAINED	**GOAL 6.2: AMENITY VALUES ARE MAINTAINED**
INDICATOR 6.1.2 **Appearance of the managed forest relative to unmanaged forest**	**INDICATOR 6.1.2** **Appearance of the managed forest relative to unmanaged forest**
STANDARD 6.2.1.1 Visible impacts on the pleasantness, aesthetic coherence, and cultural and	**STANDARD 6.2.1.1** Visible impacts on the pleasantness, aesthetic coherence, and cultural and

SFM PLANS

recreational attributes of the forest are generally not discernible at the landscape level.

STANDARD 6.2.1.2

Where forests managed by coupe systems are close to public use areas, visual impacts shall be minimised by limiting the size of coupes in critical areas.

STANDARD 6.2.1.3

To minimise the impacts of coupe felling:

› trees shall not be felled into the crowns of trees to be retained, as even relatively minor damage to surrounding trees can lead to physiological stress and attack by fungi and wood-boring insects;
› the crowns of felled trees shall, as far as possible, be distributed throughout the coupe, where distribution can be achieved without unnecessary damage to beech species advanced growth;

SFM PERMITS

recreational attributes of the forest are generally not discernible at the landscape level.

STANDARD 6.2.1.2

Where forests managed by coupe systems are close to public use areas, visual impacts shall be minimised by limiting the size of coupes in critical areas.

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› the crowns of felled trees shall, as far as possible, be distributed throughout the coupe, where distribution can be achieved without unnecessary damage to beech species advanced growth;

SFM PLANS

- stumps should generally not exceed 30–50 centimetres in height.

STANDARD 6.2.1.4

To reduce adverse aesthetic effects of extraction and landings:

- trees shall be trimmed to merchantable specifications as far as possible at the felling site, to avoid the build-up of large quantities of waste material on landings;
- landings established to process logs shall be the minimum area necessary to enable safe and efficient sorting, loading and transportation from the forest.

SFM PERMITS

- stumps should generally not exceed 30–50 centimetres in height.

STANDARD 6.2.1.4

To reduce adverse aesthetic effects of extraction and landings:

- trees shall be trimmed to merchantable specifications as far as possible at the felling site, to avoid the build-up of large quantities of waste material on landings;
- landings established to process logs shall be the minimum area necessary to enable safe and efficient sorting, loading and transportation from the forest.

CRITERION 7

FORESTS ARE MONITORED AND RECORDS ARE MAINTAINED

SFM PLANS

GOAL 7.1: NATURAL VALUES ARE MONITORED ON A REGULAR BASIS

INDICATOR 7.1.1

Indicator species measurement, flora and fauna description

STANDARD 7.1.1.1

Forest descriptions, including fauna observations/counts including those for any identified indicator species, shall be reviewed at no more than ten-year intervals. Regular inspections shall be carried out where specific values are identified (individual species or aggregates of species).

INDICATOR 7.1.2

Forest composition and structure (including habitat trees)

SFM PERMITS

GOAL 7.1: NATURAL VALUES ARE MONITORED ON A REGULAR BASIS

INDICATOR 7.1.1

Indicator species measurement, flora and fauna description

STANDARD 7.1.1.1

Where necessary measures to retain or enhance flora and fauna are specified in an approved SFM Permit and any of these measures require monitoring, inspection for the specific value(s) initially identified for protection shall be undertaken during the term of the SFM Permit, according to timing and method specified and with outcomes recorded as specified.

INDICATOR 7.1.2

Forest composition and structure (including habitat trees)

SFM PLANS	SFM PERMITS
STANDARD 7.1.2.1	**STANDARD 7.1.2.1**
Forest inspection and where necessary supplementary forest description and inventory shall be undertaken periodically to confirm that species composition and structure (including habitat trees) are being maintained.	Forest inspection and where necessary supplementary forest description shall be undertaken within the term of the permit to confirm that species composition and structure (including habitat trees) are being maintained.
INDICATOR 7.1.3: Forest margins, wetlands and clearings	**INDICATOR 7.1.3:** Forest margins, wetlands and clearings
STANDARD 7.1.3.1	**STANDARD 7.1.3.1**
Forest margins, wetlands and natural clearings shall be inspected and records updated regularly. Appropriate management responses are implemented to ensure natural values and forest stability are maintained.	Forest margins, wetlands and natural clearings shall be inspected and records updated regularly. Appropriate management responses are implemented to ensure natural values and forest stability are maintained.
GOAL 7.2: AMENITY VALUES ARE MONITORED ON A REGULAR BASIS	**GOAL 7.2: NOT APPLICABLE**
INDICATOR 7.2.1 Forest appearance at the landscape level, pleasantness, aesthetic coherence and cultural and recreational attributes	**INDICATOR 7.2.1** Not applicable

SFM PLANS	SFM PERMITS
STANDARD 7.2.1.1 Forest inspection shall be undertaken and records updated regularly to determine any change in forest amenity values.	**STANDARD 7.2.1.1** Not applicable
GOAL 7.3: FOREST GROWTH, RECRUITMENT AND MORTALITY IS MONITORED	**GOAL 7.3: NOT APPLICABLE**
INDICATOR 7.3.1 **Results from monitoring harvest sites and permanent sample plots**	**INDICATOR 7.3.1** **Not applicable**
STANDARD 7.3.1.1 Prescriptions shall be included in SFM Plans for the establishment, re-measurement and reporting of results from monitoring permanent sample plots (PSPs).	**STANDARD 7.3.1.1** Not applicable
STANDARD 7.3.1.2 Sufficient PSPs shall be established within five years of registration of SFM Plans to cover the range of forest types and broad site types existing in the forest. These shall incorporate forest reconnaissance (description).	**STANDARD 7.3.1.2** Not applicable

SFM PLANS

GOAL 7.4: FOREST REGENERATION IS MONITORED ON A REGULAR BASIS

INDICATOR 7.4.1
Records of location and status of regeneration on harvest sites

STANDARD 7.4.1.1
Inspection of harvest sites shall be undertaken within five years of harvest. Records of site location, seedling density and height (both planted and natural) by species shall be maintained.

GOAL 7.5: SILVICULTURAL OPERATIONS ARE RECORDED

INDICATOR 7.5.1
Supplementary planting

STANDARD 7.5.1.1
Records shall be kept of the location, species and numbers of seedlings planted. Planting sites will be indicated on maps maintained by the landowner.

SFM PERMITS

GOAL 7.4: FOREST REGENERATION IS MONITORED ON A REGULAR BASIS

INDICATOR 7.4.1
Records of location and status of regeneration on harvest sites

STANDARD 7.4.1.1
Inspection of harvest sites shall be undertaken within five years of harvest. Records of site location, seedling density and height (both planted and natural) by species shall be maintained.

GOAL 7.5: SILVICULTURAL OPERATIONS ARE RECORDED

INDICATOR 7.5.1
Supplementary planting

STANDARD 7.5.1.1
Records shall be kept of the location, species and numbers of seedlings planted. Planting sites will be indicated on maps maintained by the landowner.

SFM PLANS

STANDARD 7.5.1.2

Inspection of planting sites one year and five years after planting shall be undertaken and survival of seedlings recorded. Thereafter, planting sites need to be inspected periodically (at least five-yearly) to monitor survival.

INDICATOR 7.5.2
Forest health

STANDARD 7.5.2.1

Notes of observations of general forest health, as indicated by insect and fungal attack, canopy colour and density, and mortality of edge trees, shall be made when harvest sites are inspected for regeneration.

INDICATOR 7.5.3
Forest tending

STANDARD 7.5.3.1

Silvicultural records to be kept shall include site/coupe number and location, estimated regeneration density before thinning, density (or spacing) after thinning, pruning height

SFM PERMITS

STANDARD 7.5.1.2

Inspection of planting sites one year and five years after planting shall be undertaken and survival of seedlings recorded.

INDICATOR 7.5.2
Forest health

STANDARD 7.5.2.1

Notes of observations of general forest health, as indicated by insect and fungal attack, canopy colour and density, and mortality of edge trees, shall be made when harvest sites are inspected for regeneration.

INDICATOR 7.5.3
Not applicable

STANDARD 7.5.3.1

Not applicable

SFM PLANS

and predominant mean height (average height of the 100 tallest individuals per hectare).

INDICATOR 7.5.4
Harvest regulation and records

STANDARD 7.5.4.1
Harvest records shall be maintained, by species and location, for each year harvesting is undertaken.

STANDARD 7.5.4.2
The volume of standing trees selected and marked for harvest shall be determined from the measurement of diameter at breast height (1.4 metres above ground level) with deduction as appropriate for visible abnormality (excessive butt swell, fluting/flanging) that renders any section of a tree bole (or toplog) not capable of being milled, the height of the main stem of the tree to a predetermined top diameter (usually 15 centimetres, or the point at which the main stem branches into the crown), and estimates of centre girth

SFM PERMITS

INDICATOR 7.5.4
Harvest regulation and records

STANDARD 7.5.4.1
Harvest records shall be maintained, by species and location, for each year harvesting is undertaken.

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SFM PLANS

diameter and length of any toplogs. These measurements are to be made at the time of selection for harvest and, along with the volume determined from them, be recorded on a species by species basis.

STANDARD 7.5.4.3

Harvest regulation shall be conducted using equivalent units of measurement and volume estimation to the inventory and the approved harvest volumes in SFM Plans. Where weight scale is used to measure and control the harvest of smallwood products weights shall be converted to equivalent roundwood measure for reporting purposes.

INDICATOR 7.5.5
Recovered timber volumes

STANDARD 7.5.5.1

The quantity of timber harvested, by species, and its destination, shall be recorded.

SFM PERMITS

diameter and length of any toplogs. These measurements are to be made at the time of selection for harvest and, along with the volume determined from them, be recorded on a species by species basis.

STANDARD 7.5.4.3

Harvest regulation shall be conducted using equivalent units of measurement and volume estimation used in forest appraisal or estimation of the standing volume on which approved harvest volumes were determined and the approved harvest volumes in SFM Permits. Where weight scale is used to measure and control the harvest of smallwood products weights shall be converted to equivalent roundwood measure for reporting purposes.

INDICATOR 7.5.5
Recovered timber volumes

STANDARD 7.5.5.1

The quantity of timber harvested, by species, and its destination, shall be recorded.

CRITERION 8
COMPLIANCE WITH OTHER RELEVANT LEGISLATION

SFM PLANS

GOAL 8.1: ENSURE APPLICATION OF THE FORESTS ACT IS COMPATIBLE WITH THE OBLIGATIONS OF LANDOWNERS UNDER OTHER LEGISLATION

INDICATOR 8.1.1
Non-compliance of activities (whether proposed or conducted) under the Forests Act with other legislation or codes of practice

STANDARD 8.1.1.1
SFM Plans and Annual Logging Plans comply with all other laws, regulations and where appropriate, codes of practice, including Health and Safety in Employment, relevant Regional and District Plans and Rural Fire Regulations.

STANDARD 8.1.1.2
SFM Plans shall specify:

› the status and date of the relevant District and Regional Plan;

SFM PERMITS

GOAL 8.1: ENSURE APPLICATION OF THE FORESTS ACT IS COMPATIBLE WITH THE OBLIGATIONS OF LANDOWNERS UNDER OTHER LEGISLATION

INDICATOR 8.1.1
Non-compliance of activities (whether proposed or conducted) under the Forests Act with other legislation or codes of practice

STANDARD 8.1.1.1
SFM Permits and Annual Logging Plans comply with all other laws, regulations and where appropriate, codes of practice, including Health and Safety in Employment, relevant Regional and District Plans and Rural Fire Regulations.

STANDARD 8.1.1.2
Not Applicable

SFM PLANS	SFM PERMITS
› section or clause numbers of relevant provisions; › a statement of the provisions affecting management of the forest (e.g. whether proposed activities are permitted, discretionary, controlled etc.); › any conditions pertaining to the activities.	
STANDARD 8.1.1.3 No prescription in an SFM Plan shall contravene rules contained in the relevant Regional or District Plan.	**STANDARD 8.1.1.3** No prescription in an SFM Permit shall contravene rules contained in the relevant Regional or District Plan.
STANDARD 8.1.1.4 The Health and Safety at Work Act, 2015 and Code of Practice shall take precedence in any situation where there is a conflict between safety and health and prescribed silvicultural practices in approved SFM Plans or approved Annual Logging Plans. If a potential conflict is identified between the code and any prescription in a draft SFM Plan or Annual Logging Plan submitted for approval, the Plan shall be	**STANDARD 8.1.1.4** The Health and Safety at Work Act, 2015 and Code of Practice shall take precedence in any situation where there is a conflict between safety and health and prescribed silvicultural practices in approved SFM Permits or approved Annual Logging Plans. If a potential conflict is identified between the code and any prescription in an SFM Permit application or Annual Logging Plan submitted for approval,

SFM PLANS	SFM PERMITS
amended to either remove the source of the potential conflict or to ensure safe work practices take precedence.	the Plan shall be amended to either remove the source of the potential conflict or to ensure safe work practices take precedence.
STANDARD 8.1.1.5 The Fire and Emergency New Zealand Act 2017, associated regulations and Management Code of Practice shall take precedence in any situation where there is a conflict between fire protection required by the above legislation and prescribed practices in approved SFM Plans or approved Annual Logging Plans. If a potential conflict is identified between the regulations/code and any prescription in a draft SFM Plan or Annual Logging Plan submitted for approval, the draft SFM Plan or Annual Logging Plan shall be amended.	**STANDARD 8.1.1.5** The Fire and Emergency New Zealand Act 2017, associated regulations and Management Code of Practice shall take precedence in any situation where there is a conflict between fire protection required by the above legislation and prescribed practices in approved SFM Permits or approved Annual Logging Plans. If a potential conflict is identified between the regulations/code and any prescription in an SFM Permit application or Annual Logging Plan submitted for approval, the SFM Permit application or Annual Logging Plan shall be amended.

PART 2

GUIDELINES AND EXPLANATORY MATERIAL

CRITERION 1

MANAGE INDIGENOUS FORESTS IN ACCORDANCE WITH APPROVED AND REGISTERED SUSTAINABLE FOREST MANAGEMENT (SFM) PLANS AND PERMITS

SFM PLANS

GOAL 1.1: DRAFT SFM PLANS SUBMITTED FOR APPROVAL ADDRESS THE MATTERS SET OUT IN PART 3A AND THE SECOND SCHEDULE TO THE FORESTS ACT 1949

SFM PERMITS

GOAL 1.1: SFM PERMIT APPLICATIONS SUBMITTED FOR APPROVAL ADDRESS THE MATTERS SET OUT IN PART 3A AND THE SECOND SCHEDULE TO THE FORESTS ACT 1949

SFM PLANS & PERMITS

INDICATOR 1.1.1: COMPLIANCE WITH PART 3A AND THE SECOND SCHEDULE TO THE FORESTS ACT

Part 3A and the Second Schedule to the Forests Act 1949 specify the minimum requirements for incorporation in any draft SFM Plan and in SFM Permit applications. These are the basis of requirements set out in Standard 1.1.1.1 in Part 1. Other standards specified under Criteria 2–8 of these MPI Standards indicate the scope and quality of information required in draft SFM Plans and SFM Permit applications. The Forests Act also prescribes the term of any SFM Plan and of SFM Permits.

An SFM Plan must have effect for at least 50 years, except when a landholding has a term of less than 50 years, in which case the term of the SFM Plan must be for the balance of the term of the landholding. The term has effect from the date of approval of the SFM Plan.

An SFM Permit has effect for ten years from the date of registration.

Generally, draft SFM Plans will vary in detail and, while containing at least the prescribed information, may be set out in the form that is deemed most effective and efficient for the forest owner.

MPI recommends that SFM Permit applications are made on forms provided by MPI.

Draft SFM Plans and SFM Permit applications are commented on by the Director General of Conservation and in the case of Māori land, the Chief Executive of the Ministry of Māori Development (Te Puni Kōkiri) prior to their approval. Te Puni Kōkiri may advise MPI on the authority of the trustees-applicants to apply for the harvesting of indigenous timber on Māori land. Te Puni Kōkiri and the Department of Conservation may also make recommendations on the management of the forest.

Standard 1.1.1.1 (see page 10) details the information required in draft SFM Plans and SFM Permit applications.

CRITERION 2

RETAIN AND ENHANCE NATURAL VALUES

An inter-departmental memorandum developed between MAF and the Department of Conservation (DOC), titled *Guide to Associated Roles of the Ministry of Agriculture and Forestry and the Department of Conservation under Part 3A of the Forests Act, 1949* (dated 16 November 2000), defines natural values as "the attributes of the individual and interrelated biological and physical components, and processes of an area".

These components and processes are further defined as follows:

› Biological components of an area include the species/sub-species, populations and other groupings of plants and animals that are present.
› Physical components include the geology, geological features (e.g. fossils and faults), climate, hydrology, landforms, soil parent material and soil.
› Biological and physical processes include plant and animal reproduction, succession of vegetation types, erosion, hydrological processes, soil formation, and natural and human disturbances. The combination of the components and processes form habitats (i.e. the suite of resources that determine the presence, survival and reproduction of a population), communities and ecosystems.
› Those attributes of a component or process include its number, size, shape, distribution and position, its distinctiveness compared to other components, its viability, its rarity and its contribution to the ecological system(s) of which it is a part. These attributes may further be considered in different spatial or temporal contexts. This means describing the attributes

relative to the area covered by the application or to the wider region, and relative to different time periods.

Using the above frame of reference, the most practical method for assessment should then be to consider:

- existing conditions in the forest at the time of application;
- the scale and scope of any component or process;
- the likely impact(s) of management and capacity for recovery;
- any measures necessary for enhancement or restoration.

Smith *et al.* (1997) provides a comprehensive coverage of silvicultural management systems. Of the systems described, single-tree, group selection and variations of the shelterwood system are examples that are applicable to near-natural forest management. They are not described in detail here; rather the specific silvicultural prescriptions contained in the Second Schedule to the Forests Act are stated for the species groups described therein.

The Second Schedule prescriptions incorporated in standards for Criterion 2 reflect some of the ecological characteristics of the species and species groups concerned, and while reflecting many elements of the silvicultural systems described in Smith *et al.* (1997), they are limited in their coverage and detail.

Reference to Smith *et al.* (1997), or other silvicultural texts, and the guidelines and references in this document, will provide a basis for implementing and refining sustainable forest management prescriptions and practices for New Zealand species and species groups at stand level.

Ecological site classification is a method for consideration in SFM Plan formulation that can facilitate identification and management of the range of natural values that comprise sustainable forest management. It takes account of the variability (including landform and topography, soils, aspect, flora (species composition, size, structure and growth rates) and fauna) often present in even relatively small forest areas. The variability of these attributes means a range of silvicultural and management strategies is likely to be required for a forest area under sustainable management.

Objectives of management that can be facilitated under the ecological site classification system include:

› maintaining structural dominants;
› maintaining compositional diversity;
› ensuring adequate regeneration;
› sustaining timber production;
› minimising impacts of weeds and pests;
› protecting rare species and communities.

Ecological site classification provides a framework for management planning and implementation – a means of defining management units, setting the objectives in respect of each unit and prescribing appropriate silviculture and management and monitoring strategies.

Svavarsdottir *et al.* (1999), Allen *et al.* (2002) and Allen *et al.* (2003) are useful references on development and application of ecological site classification systems, and give examples for different forest types.

SFM PLANS & PERMITS

GOAL 2.1: SILVICULTURAL SYSTEMS EMPLOYED RETAIN THE FOREST'S NATURAL VALUES

SFM PLANS & PERMITS

INDICATOR 2.1.1: FLORA AND FAUNA SPECIES

This may include species population estimates from permanent monitoring of the forest or information obtained from monitoring a number of indicator species, for example hole-nesting birds such as kaka or kakariki, plants such as mistletoe (*Peraxilla* spp., *Alepis* sp.), or rata. For example, monitoring of permanent sample plots, and bird counts, can identify changes in frequency and distribution of key indicator species, possibly reflecting change in forest conditions.

Standard 2.1.1.1 (see page 13) requires flora and fauna to be maintained.

The presence or absence of a particular animal species may not always reflect forest management impacts. For example, some birds (pigeon and kaka, for example) may have territories larger than the forest area. Also, decline of a species may be a reflection of a wider geographical trend, and not specifically a consequence of forest management. However, observations (e.g. bird counts) undertaken at the same time each year may identify trends that reflect impacts of forest management systems. For example, positive trends in bird frequencies may be identified where high levels of predator control are achieved, and negative population trends may be identified where insufficient old trees (carrying high epiphyte loadings, invertebrate populations and containing cavities) are retained for hole-nesting birds and bat colonies.

SFM PLANS & PERMITS

INDICATOR 2.1.2: PRESENCE OF OLD, LARGE TREES WITH HIGH HABITAT VALUES

Some trees across all size classes need to be retained to complete their growth cycle, to maintain a representation of old trees with high habitat values in a forest area. The frequency and distribution of large, old trees within forest areas often reflects forest type, past disturbance and the stage of forest development. It is therefore difficult to provide a guide as to the numbers of such trees that should be retained.

In a mixed-age forest, retention of as few as three such trees per hectare, with ongoing recruitment of trees from younger age cohorts (to maintain this frequency in the long term), may reflect the natural state of the forest, on average. Absolute numbers, or the desirable range (per hectare) across the forest will need to be determined forest by forest. This will be a component of inventory, forest description and post-harvest assessments.

Management of beech forest in coupes will limit suitable habitat for plant or animal species that are reliant on old and dead trees with high biodiversity and habitat values. The exclusion of harvesting from riparian areas and the retention of "patches" of unmanaged trees may be sufficient to maintain habitat for dependent species. Where bird species are present that are dependent on old trees, coupe size can be varied to retain occasional patches containing old trees. Specification of trees to be retained may be determined in approved Annual Logging Plans.

Standard 2.1.2.1 (see page 13) provides for retention of trees with high habitat value.

Standard 2.1.2.2 (see page 14) provides for retention of trees within size classes.

SFM PLANS & PERMITS

INDICATOR 2.1.3: STAND COMPOSITION, STRUCTURE, REGENERATIVE PATTERNS AND GROWTH

The existing stand composition and structure, combined with physical factors such as topography, soils and climate, will influence the choice of management system and the selection of equipment, such as harvesting and transport machinery.

The Forests Act categorises New Zealand's indigenous timber species broadly into three groups:

- kauri and podocarp species;
- shade-tolerant and exposure-sensitive broadleaved hardwood species; and
- beech and other light-demanding species.

Kauri and podocarps such as rimu are generally encountered as individuals or groups, emergent over a mixed broadleaved hardwood dominant canopy. For example, rimu is commonly present in Taranaki hill-country forest in low densities (often less than 10 stems per hectare), with occasional kahikatea, matai, miro and totara, over-topping a tawa-dominant canopy, with less frequent hinau, rewarewa, pukatea, northern rata and maire. Where forest is accessible to ground-based machinery, there are often tracks through the forest where rimu, one of the most valuable timber species, has been subjected to previous selective harvesting. There are few remaining forests on private land where the podocarps occur as the dominant species in high densities as they do on the glacial terraces of Westland, the volcanic pumice soils of the central North Island (rimu), or on alluvial terraces (kahikatea).

Of the commercial broadleaved hardwood species, few would be regarded as a light-demanding species for most of their growing cycles. Rewarewa is one example, and is an early coloniser of forest gaps and regenerating cutover forest. Most broadleaved hardwood species generally require some protection and shade to successfully regenerate and survive as seedlings, and may also rely on the presence of bare mineral soil or particular forest floor conditions. Some, like tawa, are shade-tolerant and exposure-sensitive.

Significant canopy disturbance and exposure of tawa forest edges, such as occur on the perimeter of large gaps created by harvesting operations, can lead to interruptions to regeneration processes (gaps may regenerate in tree ferns or light-demanding species such as rewarewa) and exposed forest edges may show signs of dieback. In such circumstances the maintenance of forest composition, regenerative capacity, structure and health depends on the selection of appropriate management systems.

The podocarp species can display age-class distributions heavily biased towards the older age classes. This poses a problem for managers required to maintain perpetually sustainable harvests. Forest management planning must incorporate consideration of forest changes that are either already occurring or likely to occur in future. In such forests, selection for harvest should focus on trees to be retained (vigorous, healthy trees along with trees with high habitat values) so that the timber resource is eked out as long as possible (taking the average longevity of the species and age class structure into account).

Of the beech species, red beech is the most light-demanding. Silver beech displays a high level of shade tolerance and often displays a reverse “J” size class distribution within the forest (high densities of stems in the smaller size classes) typical of shade-tolerant species.

Beech exhibits faster growth rates (in relation to most other indigenous species groups), and has the ability to seed prolifically every few years (mast seed years). This characteristic, coupled with an apparent ability for diameter growth to be enhanced by thinning, encouraged forest managers to trial intensive silvicultural management of beech in even-aged stands. More recently some landowners have opted to manage beech on a more conservative basis, trading off the benefits of tending and fast growth against less intensive and less expensive forest management systems that can, if carefully implemented, also result in healthy forests. This requires acceptance of lower harvest rates from the same stand as would be sustainable under intensive silviculture.

Forest management must be based on a good understanding of the stand history, i.e., the factors that have contributed to the existing stand structure (both natural and anthropogenic). Forest managers must also have an appreciation of what, if any, successional changes are occurring or are likely to occur, and a clearly defined vision of the future state of individual forest stands.

Comparisons of monitoring data from Permanent Sample Plots (PSPs) and key flora indicator species in managed forest and unmanaged forest of similar type (whether as an area within the forest area subject to management, or in another forest with similar attributes) are a way of assessing effects of management on maintenance of stand composition and structure.

Standard 2.1.3.1 (see page 14) requires maintenance of stand structure.

SFM PLANS & PERMITS

INDICATOR 2.1.4: FOREST MARGINS, WETLANDS AND NATURAL CLEARINGS

Ecotones such as forest margins, natural clearings and wetlands are important components of natural forest ecosystems. They often support plant and animal species or communities that are rarely encountered within the forest. Bat colonies, for example, are often located in hollow trees near forest margins, and some bird species are more commonly encountered near open pasture or natural clearings. Many privately owned indigenous forest areas are commonly bounded (partially or totally) by developed pasture land and have high perimeter to area ratios.

A significant proportion of such forest areas is susceptible to damage resulting from storms, impacts of grazing stock (where no fences exist), and invasion of forest gaps by weed species. Harvesting on or close to forest edges can exacerbate these potential risks. Where private forests consist of small discrete patches the potential risks to forest margins are amplified.

Burns (2006) is a source of information on edge effects to forest areas and management considerations. Key among these are protection of forest margins and minimising management impacts within areas already subject to edge effects.

Standard 2.1.4.1 (see page 14) specifies control on harvesting near forest margins, wetlands and natural clearings, being zones of high natural value.

SFM PLANS & PERMITS

GOAL 2.2: SILVICULTURAL PRACTICES MEET SECOND SCHEDULE PRESCRIPTIONS

SFM PLANS & PERMITS

INDICATOR 2.2.1: HARVEST SELECTION, INTENSITY AND DISTRIBUTION

KAURI AND PODOCARP SPECIES

The Second Schedule to the Forests Act requires single-tree or small-group harvesting of kauri and podocarp species, using low-impact techniques and that harvesting be (as far as possible) restricted to selective removal of trees predisposed to windthrow or early death, subject to maintaining forest character and structure.

Single-tree or small-group harvesting of kauri and podocarp species

Kauri and podocarp species will generally be present as single trees or in clumps of trees distributed through the forest. On areas subjected to previous harvesting and significant ground disturbance there may be quite dense patches of regenerated forest.

In harvesting small groups, the selection of group size may be dictated in part by forest structure and topography but should take into account stand stability and the distribution of stems throughout the forest. Generally, group size should not exceed five podocarp trees. The harvest should be undertaken with the aim of maintaining the existing distribution of stems throughout the forest. The exception to this is where seral (e.g. regenerating) forest is going through natural compositional and structural change.

Standard 2.2.1.1 (see page 15) requires and defines selection harvesting of kauri and podocarp species.

Use of low-impact management systems for kauri and podocarp harvesting

The management of rimu in South Westland in the 1960s and 1970s by ground-based harvesting identified a number of prerequisites to maintaining healthy stands capable of producing sustainable harvests:

- Forest roads must be well engineered. Forest roading that interfered with natural drainage patterns had an adverse impact on forest health.
- Single-tree and small-group harvesting reduces the impacts of harvesting. Opening large gaps in dense mature and semi-mature rimu stands increased the forest's susceptibility to toppling.
- Ground-based machines need to be confined to well drained country and preferably be configured for low ground-pressure operations. Machines operating too close to individual trees damaged the surface-feeding root systems and had an adverse impact on forest health. These impacts were exacerbated by the use of heavy machinery that broke through the poorly drained gley soils.

The advent of helicopter harvesting all but eliminated the in-forest problems – that is, it enabled reductions to roading density and removed the need to have ground-based harvesting equipment in the forest.

The steep topography and susceptibility to erosion of much of the private forested country in the North Island has been a major disincentive to management of these forests in the past. The cost of access and difficulty of operating machinery on the land has only recently been alleviated by the use of helicopter harvesting. Even then the use of heavy-lift helicopters is not always economically viable unless there are economies of scale and the species under management commands high timber prices.

For a high proportion of such forests the lifting by helicopter of whole tree lengths, prepared logs or flitches sawn on site using portable mills is likely to be the only practicable harvesting method. Information regarding helicopter harvesting is contained in Hammond (1995), James and Norton (2002), and Colley (2005).

Where ground-based harvesting is to be undertaken, construction should, as far as practicable, result in roads and tracks that:

- avoid damage to valuable tree stocks and minimise damage to other vegetation;
- are sited on well drained topography;
- minimise formation work (cutting, filling, side-casting);
- limit the need for machines to move off the tracks to undertake timber extraction.

The same considerations apply to formation of any access roads, tracks or landings required within a forest area to facilitate aerial extraction or improve its economics.

Once harvesting operations are completed, inspection and treatment of temporary tracks should be undertaken as necessary (e.g. ripping and provision of drainage channels) to reduce future impacts on the forest.

It is advantageous for dozers to be set up for low ground-pressure operations. Even on well drained terrain, repeated passes over the same track may cause soil compaction, significant ground disturbance and interference with natural drainage patterns. This should be avoided as much as possible.

MPI may undertake post-harvest assessments to verify implementation of low-impact techniques and assess effects of management activities. Typical parameters checked include inspection of harvest sites for group size and intensity or distribution across the forest area, and qualitative assessment of operational impacts including damage to the remaining standing forest.

Standard 2.2.1.2 (see page 15) requires low-impact techniques for harvesting kauri and podocarp species.

Standard 2.2.1.3 (see page 15) lists requirements for establishing temporary access tracks.

Sustainable management of indigenous forest requires that damage resulting from harvesting and other operations is minimised, forest structure is maintained and natural values (e.g. understorey species, soil litter layer, soil litter biota, and coarse woody debris) are retained.

O'Loughlin (New Zealand Institute of Forestry, 1995) states that:

> …without root reinforcement, the soils on many slopes over 30 degrees may suffer shallow landsliding during only moderate storms. As a general rule, slopes over 32 degrees where shallow soils overlay impermeable substrata are most susceptible to shallow mass wasting after forest removal.

Any rules in Regional and District Plans may determine slope limits for various types of forest activities, including aerial extraction and vegetation clearance, and must be adhered to in forest operations.

Limited trials have been undertaken with small-scale, suspended-carriage cable systems (Baker *et al.*, 1996). Such systems may offer advantages over tracked or wheeled machines (e.g. by reducing ground impacts) and may have application in beech forests.

On steep slopes (generally regarded as over 25 degrees) and on poorly drained soils, aerial extraction is a preferred option to ground-based extraction (and may be mandatory under any rules in Regional and District Plans). Where not mandatory, the following matters need to be considered when evaluating helicopter extraction.

- Some environmental impacts can be avoided, e.g. ground disturbance.
- Harvesting can be undertaken economically over relatively large, low-stocked areas.
- Timely recovery of windthrown timber is possible after storm events, even in unroaded areas.
- Harvesting can be undertaken on otherwise inaccessible terrain.
- Access for invasion of the forest by weeds and pests is reduced.
- The need for high density roading and tracking is eliminated.
- The choice of machine and timing of harvesting are important considerations.
- Where average tree size is large, the economical use of heavy-lift helicopters may require co-operation between a number of landowners to keep unit costs down. Alternatively, smaller machines may be successfully used in combination with on-site breaking down of large trees using portable mills. This latter alternative has the additional advantage of retaining the maximum possible quantity of bark, wood and crown material for nutrient recycling.
- Without some access roading, ongoing forest management operations are likely to be more time-consuming.
- The limited ground disturbance resulting from helicopter harvesting may not be optimal for regeneration of the harvested species. Where access is difficult, consideration should be given to the planting of replacement seedling stocks at the time of extraction.

- It may be uneconomical to extract less valuable species.
- Helicopters are well suited to harvesting as single trees and small groups.

Standard 2.2.1.4 (see page 16) defines situations when aerial extraction is to be considered.

Harvest of kauri and podocarp trees predisposed to windthrow or early death

Where kauri and podocarp stands comprise predominantly mature to old trees (a common feature of podocarp forest), successful management of the forest is likely to be based around harvesting and recovering existing or imminent mortality rather than healthy stems. In such instances mortality, either as dying trees or windthrown trees, is likely to involve as much timber as that accumulated as increment by healthy stems.

Management will involve pre-harvest forest assessment where trees are selected for harvest on the basis of declining health or susceptibility to windthrow. Indicators of declining heath and susceptibility to windthrow include:

- advanced crown dieback;
- significant physical damage to the crown or stem;
- major damage to root systems that is likely to affect health and stability;
- the presence of major stem rot likely to affect health and stability.

Standard 2.2.1.5 (see page 16) prescribes tree selection timing and selection attributes applicable to kauri and podocarp species.

Taking a proportion of the “at-risk” trees will reduce the number of stable/healthy trees harvested in the medium term. The principle applied to the management of mixed-age, continuous-cover forest of “retaining the best and selecting the worst (for harvest)”, is particularly important in podocarp and kauri forests. Application of this principle maximises the lead-time necessary to allow the recruitment into the stand of regenerated or planted stock and contributes to the maintenance of stand stability. Unlike many of the broadleaved hardwood species, whose timber deteriorates quickly once the tree is dead, the heartwood of some podocarps e.g. rimu, matai and totara is moderately durable and a high proportion of quality timber may be obtained from trees that have died or become windthrown.

Where there is a good distribution of size and age classes, trees should be harvested across the range. This is important to maintain biodiversity, as large and unhealthy trees are often the most important as habitat for other species. Large, heavily crowned rimu for example, support a wide variety of flora and fauna species (lianas, epiphytes, birds, insects, etc.). Where this is recognised as an important provision of an SFM Plan or SFM Permit, a specification should be made in terms of the numbers of trees to be selected across the range of size classes so that a significant proportion of moribund/dead standing stems is retained.

It is recommended that a proportion of trees be allowed to complete their life cycle (see discussion under Goal 2.1). This may not be feasible where beech forests are managed in coupe fellings.

There are many publications covering the ecology and management of rimu. Useful references include Norton *et al.* (1988); Hammond (1995); Svavarsdottir *et al.* (1999), Urlich *et al.* (1999) and Smale (2005).

Standard 2.2.1.6 (see page 17) specifies maintenance of habitat values combined with harvesting Kauri and podocarp species.

SHADE-TOLERANT AND EXPOSURE-SENSITIVE BROADLEAVED HARDWOOD SPECIES

Forests Act requirements for harvesting kauri and podocarps also apply to shade-tolerant and exposure-sensitive broadleaved hardwood species (with the exception of the prescription relating to harvesting trees predisposed to windthrow or early death). The explanatory material outlined under "Single-tree or small-group harvesting" and "Use of low-impact management systems for kauri and podocarp harvesting" above, also applies to this species group, in terms of operational considerations.

Standard 2.2.1.7 (see page 17) requires and defines selection harvesting of shade-tolerant and exposure-sensitive species.

Standard 2.2.1.8 (see page 17) requires low impact techniques for harvesting shade-tolerant and exposure-sensitive species.

Standard 2.2.1.9 (see page 17) lists requirements for establishing temporary access tracks.

There are some additional considerations, however. Shade-tolerant species such as tawa are often represented in a stand by large numbers of stems in smaller size classes. The "reverse J" size-class distributions often exhibited by shade-tolerant species lend themselves to uneven-aged management. The success of management of such species will be heavily influenced by both tree selection for harvest and the protection of the future "crop" trees from harvesting damage.

Sustainable forest management must be economically viable and to achieve a satisfactory economic outcome there may need to be a selection of trees for harvest across the quality spectrum. Unlike kauri and the podocarps, much of the timber of many broadleaved hardwood species may have limited commercial value once the trees are in a state of deterioration or dieback. In such circumstances a balance may be required between sustaining the forest's natural values and deriving an economic return. Such considerations may also influence the "period of adjustment" selected to achieve the desired forest structure (refer to description of Austrian and Gerhardt's formulae, under Indicator 3.1.3) but should not compromise long-term sustainability and the intent of the Forests Act.

Where there is a risk of harvesting operations interrupting natural regeneration processes, as is the case with tawa, group harvests should be planned so that the resultant gaps are not so large that the species under management is unable to regenerate and be recruited into the gaps. Competition with tree ferns, rewarewa and other species that tend to colonise larger, well-lit gaps will compromise the owner's long-term ability to manage the species. The maximum gap size recommended for tawa is 0.014 hectare (12 metres by 12 metres) as there is anecdotal evidence (Smale *et al.*, 1986) that broadleaved hardwoods and tree ferns colonise larger gaps. This will often be the area covered by the crowns of no more than two or three trees.

Results of monitoring selection harvesting at Pureora and Whirinaki in high-density podocarp forest with a tawa component suggest tawa advanced growth (not damaged in harvesting) is not disadvantaged where controlled single-tree and group harvesting is undertaken. Smale (2005) observed a larger (more than doubled) change in tawa advanced growth stem density per hectare (post-harvest compared to pre-harvest after 44 years) in harvested forest, compared with unharvested forest over the same period.

Also, tawa advanced growth appears to respond to at least some degree of release from competition, by increased diameter growth. At Whirinaki, Steward and Dungey (2006) observed post-harvest mean diameter increment three times higher in tawa stems at the edge of harvest gaps than for those in unharvested forest, providing the degree of canopy opening had not resulted in over-exposure of trees to frost, wind and sun.

Results of regeneration monitoring undertaken at Whirinaki (Steward and van der Colff, 2006) 19 years after harvesting of between 9 and 15 percent of merchantable volume as single trees and groups of between 5 and 12 trees – mainly rimu of large stature (40–60 metres high), and also some tawa (and therefore creating a majority of harvest gaps in excess of the 0.014 hectare size recommended above) – suggest the effects of harvesting on tawa advanced growth do not pertain to regeneration. Here, numbers of tawa seedlings on extraction tracks, track margins and in harvest gaps were typically one-third of the numbers in undisturbed forest. This was with a post-harvest canopy height of 40–60 metres, creating a significant shade effect over the majority of the forest area – that would be expected to have benefited tawa regeneration. Consistent with observations of Smale *et al.*(1986), the harvest gaps at Whirinaki were found to support a dense cover of tree fern and other hardwood species, which inhibits regeneration, especially of rimu, but also of tawa (Steward and van der Colff, 2006).

The effects of harvesting implemented at Pureora and Whirinaki on tawa advanced growth and regeneration support single-tree and small-group harvesting of tawa and other shade-tolerant and exposure-sensitive species. Minimising gap size (subject to stand species composition or competition and individual site conditions) is of particular importance for securing successful natural regeneration. However, gap size assumes even more importance in mixed species stands where relatively small gaps can favour one species but may not suit another that occurs in association and is also subject to harvesting e.g. rimu in a tawa predominant stand or vice versa.

Smale *et al.* (1986) is the most useful guide to the ecology and management of tawa.

Standard 2.2.1.10 (see page 18) requires consideration of regeneration processes when harvesting shade-tolerant and exposure-sensitive species.

BEECH AND LIGHT-DEMANDING SPECIES

At the time that Part 3A of the Forests Act became law, there were only two landowners in New Zealand practising group or small coupe harvesting of beech. Beech management had otherwise been undertaken using large clearcuts, often in combination with pre-harvest scarification and retention of seed trees. More recently, a larger number of landowners have undertaken beech management employing both coupe felling (of up to 0.5 hectare coupes), and small-group harvesting. Some owners are moving to a shelterwood system of management where the harvest is conducted in one or more "thinnings" (to increase forest floor light levels to promote regeneration, yet afford some overhead protection) followed by a final harvest after a cover of regeneration has been achieved. Single-tree and small-group harvesting of the more shade-tolerant silver beech may also be an appropriate silvicultural approach.

Average daily temperatures at ground level in felled coupes can be substantially higher than in intact forest, and beech regeneration may suffer drought in large gaps (Benecke *et al.*, 1995). In areas with cold winter climates, beech regeneration can also suffer physiological drought as a result of low ground temperatures and relatively high evapo-transpiration. In these circumstances group or shelterwood management will limit these effects as well as limiting the establishment of weed species.

The area of a coupe is the area contained within the vertical projection to the ground of the edges of the crowns of standing trees surrounding the coupe (i.e. the canopy gap created by the felling of a group of trees). This differs from the term “expanded gap” which is the area measured between the edges of the trunks of trees nearest to and surrounding the coupe.

Quite small gaps may be suitable for silver beech regeneration and recruitment compared to red beech. Research conducted in West Coast red–silver beech forests (Stewart *et al.*, 1991) suggests that expanded gaps (measured between the trunks of edge trees) of less than 400 square metres (0.04 hectare) are likely to favour recruitment of silver beech, coupled with rapid gap infilling through lateral growth of edge trees. In expanded gaps greater than 400 square metres, seedlings of red beech are more likely to outgrow silver beech advanced growth and ultimately occupy the gap.

The choice of silvicultural system will depend on the species under consideration, site characteristics, climate and factors such as amenity values.

The Forests Act sets a maximum beech harvest coupe area of 0.5 hectare, unless approval has been obtained for a larger area (up to 20 hectares).

Standard 2.2.1.11 (see page 18) fixes the maximum beech coupe size (unless special approval has been obtained).

Felling of coupes exceeding 0.5 hectares

Landowners may apply to MPI for approval to harvest coupes of between 0.5 hectares and 20 hectares (Clause 67o, Forests Act). The decision to approve such applications is discretionary and is dependent on consideration as to whether felling of beech in coupes of between 0.5 hectares and 20 hectares would result in any of the following:

- a significant adverse impact on flora, fauna or other natural values;
- a significant increase in soil erosion or in the risk of soil erosion;
- a significant adverse impact on drainage or aquatic ecosystems;
- a significant impact on indigenous forest regeneration;
- a significant adverse impact on the amenity values of the forest.

MPI may elect to decline an application for felling beech in coupes of between 0.5 hectares and 20 hectares if any of the effects listed above would result. Any approval to harvest coupes between 0.5 hectares and 20 hectares must be advertised by MPI. Persons or organisations may appeal the decision to the Environment Court, pursuant to Part 11 of the Resource Management Act 1991. Similarly any owner may appeal to the Environment Court a decision of MPI not to permit an application under this provision of the Forests Act.

Standard 2.2.1.12 (see page 18) lists the factors considered by MPI in assessing any application for large coupe harvesting of beech.

Coupes vs. groups

The optimal harvest rates for beech vary not only between species, but also in relation to the management system selected. High annual diameter increments are attainable in conjunction with intensive silviculture on regenerated coupes. Where larger coupes are harvested (up to 0.5 hectares) the likelihood is that regeneration will be prolific (dependent on the periodicity of mast seed years and other site factors) and that there will be a high level of competition between individual stems as they grow. This has the effect of limiting individual stem diameter growth. Trials undertaken in Westland and Southland indicate that thinning, undertaken at the right time and to appropriate densities, will shorten the time taken for a regenerated stand to grow to optimal harvestable size. There is a risk, though, that coupes will become invaded by ferns and adventive weed species that limit early regeneration. Useful references include Wiser *et al.* (1999), Allen *et al.* (2000) and Brignall-Theyer *et al.* (2002).

The adoption of a more conservative management strategy (e.g. single-tree and small-group harvesting), and minimal forest tending is likely to require more conservative harvest rates that recognise slower individual stem growth rates and the likelihood that a proportion of natural stand mortality will not be recovered. In such circumstances proposed harvests should not exceed more than 50–60 percent of estimated gross increment. Application of this system will result in lower tending costs and is more sympathetic to existing stand structure.

In mixed-species beech forest, harvesting can elicit differing species' growth responses in remaining trees. Wiser *et al.* (2003)

observed that while red beech may be more suppressed by competition (neighbouring trees) it typically does not grow significantly faster with competition reduced e.g. by harvesting (or natural disturbance), whereas silver beech can show a marked growth response, particularly by smaller diameter trees (<40 centimetres dbh).

At small coupe (0.04–0.2 hectare) harvested sites in north Westland, silver beech trees at coupe margins exhibited an increase in mean annual diameter growth after harvesting of up to four times that of trees in unharvested forest (Wiser *et al.*, 2003). However, even with this marked increase, silver beech mean annual diameter growth did not exceed that of red beech trees at coupe margins or in intact forest (red beech diameter growth remained relatively constant, irrespective of harvesting).

Differences in species growth responses to harvesting or thinning should be considered in determining location, size and shape of harvest areas and may be used to advantage in maintaining stand composition and structure.

Smaller coupe or group harvesting increases the edge to area ratio of harvest sites and has potential to increase mortality of edge trees (e.g. through increased risk of harvest damage, exposure and incidence of pinhole beetle attack). While these potential risks exist, with appropriate care in operational activities, smaller harvest areas are not necessarily detrimental to forest health. For small coupe harvest areas (0.04–0.2 hectares) in mixed red and silver beech forest in north Westland, Wiser *et al.* (2005) noted that mortality rate in coupe edge trees was not different to that in nearby unharvested forest, and that use of small coupes was unlikely to significantly alter forest structure or composition.

Adoption of silvicultural system(s), and their implementation, will be dependent on the characteristics of individual forests, and may involve variations within systems, to be applied on a stand-by-stand or forest-type basis. Wardle (1984) provides a wide coverage of beech forest ecology and management.

Coupe separation and regeneration

A requirement of the Forests Act is that before harvesting any coupe within a distance from a harvested coupe equal to the width of the harvested coupe, regeneration on the harvested coupe must have reached a predominant mean height of four metres and have reached a stocking of the harvested species equal to or greater than the forest before harvesting.

Results of research in silver beech forest in Southland, regenerated after clearfelling in the 1920s and being coupe-harvested again under sustainable management in 2004, indicated that the mean time for regeneration and advanced growth to attain four metres was approximately 26 years (TACCRA Ltd, 2004). While this result is likely to be specific to the forest type investigated, it provides an indication of regeneration establishment time and harvest periodicity for planning forest management under a coupe-felling regime (with coupes of up to 0.5 hectares) in forest of similar type.

Standard 2.2.1.13 (see page 19) sets the minimum return-harvest period on coupe proximity.

SFM PLANS & PERMITS

INDICATOR 2.2.2: RESTOCKING OF HARVESTED KAURI, PODOCARPS AND SHADE-TOLERANT OR EXPOSURE-SENSITIVE BROADLEAVED HARDWOOD SPECIES

The Forests Act requires supplementary planting where harvesting of kauri, podocarps, and shade-tolerant and exposure-sensitive broadleaved hardwoods has been undertaken and advanced growth is lacking (insufficient to replace harvested stems). Where practicable, seedlings for planting should be raised from seed collected from the district in which the seedlings are to be planted (many species exhibit local variation and have distinct physical traits that may be genetically controlled).

Advanced growth can be described as established seedlings (30 centimetres–1.4 metres high), saplings (1.4 metres high/10 centimetres dbh) and poles (10–20 centimetres dbh). Advanced growth will often not be in close proximity to the trees selected for harvest, especially in mixed podocarp-broadleaved hardwood forests. It will tend to occur on decaying fallen tree trunks, on mineral soils turned over by uproots, or on moist sites with limited depth of organic matter where young seedlings can obtain sufficient moisture to survive dry weather conditions. Seedlings will often be found clumped under perch trees (e.g. mature broadleaved hardwoods). In mixed kauri or podocarp–broadleaved hardwood forest it may not be necessary that advanced growth is present at harvest sites to ensure forest structure is maintained, but there must be sufficient advanced growth distributed throughout the forest area.

Where there is combined advanced growth of less than about five times the density of trees over 30 centimetres dbh, replacement seedling stocks should be planted in accordance with the standards. The need for supplementary planting will be determined by MPI on the basis of review of draft SFM Plans and field inspection.

The greatest success is likely to be achieved with seedlings that have been grown in an open bed nursery or in pots and hardened off before being planted. Where helicopter harvesting is undertaken planting is most efficiently carried out at the time of timber extraction, although planting should preferably be avoided during dry summer periods.

There has been little work done on mortality rates of naturally regenerated seedlings of kauri and podocarp species. What work has been done (South Westland podocarp forests) suggests about 15 percent of naturally regenerated rimu seedlings survive to reach a height of 1.4 metres (the lower limit of the sapling category) after 35 years (James, 1998). Seedling mortality rates are likely to vary widely between species and site.

While not essential, it is logical that replacement seedlings are planted in harvest gaps but care should be taken to select planting sites where seedling roots have direct access to forest soils. Plantings on deep layers of organic material will often succumb to drought in areas prone to high summer temperatures and soil water deficit.

Standard 2.2.2.1 (see page 20) specifies when supplementary planting is necessary, and number and size of seedlings to be planted.

Standard 2.2.2.2 (see page 20) defines the geographic source of seedlings/seed to be used for planting stock.

SFM PLANS & PERMITS

INDICATOR 2.2.3: RESTOCKING OF HARVESTED BEECH AND LIGHT-DEMANDING SPECIES

Beech and light-demanding species will generally exhibit adequate natural regeneration in response to harvesting (subject to appropriate silviculture). However, the Forests Act requires supplementary planting in the event natural regeneration fails. Where there are major gaps in regeneration or where seedlings appear to be particularly sparse, perhaps as a result of vigorous fern or adventive weed growth (e.g. in larger beech coupes), consideration should be given to spot planting of seedlings to fill in regeneration gaps. Where practicable, seedlings for planting should be raised from seed collected from the district in which the seedlings are to be planted (many species exhibit local variation and have distinct physical traits that may be genetically controlled).

Planting density, coupled with any natural regeneration present, should equate to at least 500 stems per hectare (sph), typical of the numbers of poles and trees likely to be encountered in mixed age beech forests.

Standard 2.2.3.1 (see page 20) specifies when to conduct supplementary planting (and site preparation).

Standard 2.2.3.2 (see page 21) sets a minimum combined planting/natural regeneration density at harvest sites for beech and light demanding species.

Standard 2.2.3.3 (see page 21) defines the geographic source of seedlings/seed to be used for planting stock.

SFM PLANS & PERMITS

GOAL 2.3: REPRESENTATIVE AREAS ARE SET ASIDE TO PROTECT EXAMPLES OF FOREST

SFM PLANS & PERMITS

INDICATOR 2.3.1: IDENTIFICATION OF FOREST TYPES/HABITATS NOT WELL REPRESENTED IN PROTECTED AREAS

A representative area or areas (not exceeding 20 percent of the forest area) may be set aside and be unavailable for logging. A representative area will usually be recommended by DOC, but may also be requested by MPI or the landowner. Generally, a representative area will not be sought where the values identified are adequately represented in other permanently protected areas in the region.

There are occasions where high conservation values can be protected by adopting specific management conditions rather than setting the area aside (for example the maintenance of the habitat requirements for a single species). In such circumstances specific management actions shall be adopted to maintain the identified values.

Forest description in draft SFM Plans and SFM Permit applications should identify any areas a landowner seeks to have set aside as a representative area and describe the distinguishing value(s). Mapping needs to clearly show proposed areas to be set aside.

On occasion, values may be recognised through the identification of the forest (or parts of it) as a Significant Natural Area in the applicable District Plan or Regional Plan or Regional Coastal Plan. Timber harvests may be prevented, or at least a notified resource consent may be required before any indigenous timber can be harvested.

Map(s) in approved SFM Plans and Permits will show any representative areas that have been set aside.

Standard 2.3.1.1 (see page 22) defines the minimum attributes required of any representative area.

Standard 2.3.1.2 (see page 22) excludes harvesting in representative areas.

Standard 2.3.1.3 (see page 23) requires mapping of any representative area in registered SFM Plans or Permits.

SFM PLANS & PERMITS

GOAL 2.4: THE SUITE OF INDIGENOUS SPECIES PRESENT IN THE FOREST IS MAINTAINED

SFM PLANS & PERMITS

INDICATOR 2.4.1: SELECTED INDICATOR SPECIES REMAIN AT EXPECTED LEVELS OF ABUNDANCE

One of the best long-term indicators of management impacts is likely to be the comparison of the flora and fauna populations in a managed forest with a similar unmanaged forest in close proximity.

Native animal (including invertebrates, which may be among the most effective indicators of maintenance of natural values) and plant species' presence and/or frequency of occurrence, as indicated by selected indicator species in managed forest, should remain comparable with similar unmanaged forest.

Maintenance of the forest in a "near natural" state is likely to be best achieved by:

› securing adequate forest descriptive information and using this in determining management objectives (e.g. by use of the ecological site classification methods described by Allen *et al.* (2002) and Allen *et al.* (2003));

- adopting forest management systems designed to maintain the structure and composition of the forest;
- identifying any species or habitat that may be vulnerable to forest management activities and adopting management prescriptions designed to maintain them;
- monitoring the results of forest management.

In some forests a selected species or group of species may be identifiable as indicators of change; in other forests this will not be easily achieved. For example, bat colonies and the presence of rifleman, yellowhead, kaka and kakariki during the breeding season are indicators of habitat trees providing holes for nesting; abundance and health of mistletoe are indicators of pest population levels.

Useful monitoring strategies include remeasurement of permanent sample plots (PSPs); comparison of periodic forest description(s); comparison with records from comparable unmanaged forest or the forest before management; and temporary periodic assessment of specific indicators (where they have been identified).

In the event that there is doubt as to the sustainability of the forest management practices adopted, comparison of the current forest condition with the baseline forest description and inventory may indicate forest change.

Standard 2.4.1.1 (see page 23) sets the expected level of retention of indigenous flora and fauna in managed forest and its assessment by way of indicator species.

Where threatened flora or fauna are identified in the forest area, these species and the area(s) in which they occur should be described in draft SFM Plans and SFM Permit applications, along with appropriate prescriptions (measures to be taken) for their protection.

Approved SFM Plans and SFM Permits must incorporate appropriate prescriptions for protection of threatened flora or fauna species present in the forest.

Specification of protection may include, for example, prescriptions that:

- limit harvesting activity during the kiwi breeding season;
- ensure food sources for kereru or kaka are maintained;
- require the protection of identified bat-roosting trees;
- require the retention of a minimum density of senescent trees for hole nesting and insectivorous birds;
- require the retention of a minimum density of trees host to threatened plant species;
- set predator control programmes.

Such specific measures reflect local values and can only be applied on a case-by-case basis. Forest specific values may be known to the landowner and where identified on DOC databases will generally be highlighted in advice provided by DOC as part of the consultation process.

Consultation procedures between MPI and DOC, undertaken in accordance with interdepartmental protocols, are a means whereby appropriate protection measures for flora or fauna can be identified and recommended.

Information to enable the identification and measurement of "specific" indicator species to satisfy all management goals or forest locations and types is limited. The use of such indicators will only be possible in the short term where science has identified clear relationships between specific indicators and forest conditions. Some useful indicators that lend themselves to assessment of forest condition, and methods for their assessment, are contained in Handford (2000).

Porteous (1993) is a useful guide to forest restoration, covering common pest and weed species and their control, restoring food sources for native birds, and propagating and planting native species.

Standard 2.4.1.2 (see page 23) requires specific protection measures for any threatened species in the forest area.

Standard 2.4.1.3 (see page 24) recognises the contribution of DOC recommendations to MPI's application of any flora and fauna protection measures/conditions.

SFM PLANS

INDICATOR 2.4.2: STAND COMPOSITION AND STRUCTURE DOES NOT REFLECT COMPARABLE UNMANAGED FOREST NEARBY

Many private forest areas have been subject to varying degrees of harvesting activity. Some have regenerated in the absence of fire and in composition vary little from the forest before harvesting (Baxter and Norton, 1989). Some approved SFM Plans contain regenerated forest that is still recovering from earlier harvesting.

Where forest stands are in varying stages of recovery, it is unlikely that they will support harvest rates comparable to previously unmanaged forest.

It is therefore important that management plans for forest areas that include modified forest prescribe for their ongoing management.

This is best achieved by either delaying harvesting activity until the forest has recovered a predetermined proportion of its basal area/stand volume, or by reducing the proposed harvest to significantly less than the current level of growth. Either way the forest will continue to develop.

The selection of a harvest rate in these circumstances is important, as it will influence the time the forest will take to recover most or all of its structure and volume.

The harvest rate should reflect the estimated time required for the forest to develop a stocking level and size class distribution of the major tree species similar to unmanaged stands.

The Austrian or Gerhardt's formulae (see material under Indicator 3.1.3) will assist the estimation of harvest rates providing the owner has good inventory information and realistic estimates of current and expected growth rates and expected future stand volume, basal area, etc. Average stand data for similar unmanaged forest types, where it is available, in either adjacent forest or in close proximity, is likely to provide the best indication of future stand development.

Unless an SFM Plan is subject to a very long term, the full recovery of a modified forest may well require a period exceeding its initial term. The same applies to forest subject to SFM Permits.

While this may deter owners from embarking on ambitious tending schedules, it should not prevent the consideration of low level silvicultural treatment (e.g. thinning) to improve stand structure, stem growth, etc.

Richardson *et al.* (2005(a)) provides useful discussion on possibilities for restoration silviculture and gives an example of developing a restoration goal for a North Island forest containing historically logged and unlogged areas of tawa–podocarp and beech–podocarp forest types.

Standard 2.4.2.1 (see page 24) sets a management aim of returning modified forest to a near-natural state (SFM Plans only).

SFM PLANS

INDICATOR 2.4.3: SILVICULTURAL TENDING

KAURI, PODOCARP AND BROADLEAVED HARDWOOD FORESTS

Much of the private podocarp–broadleaved hardwood forest has been previously harvested. Often the harvest has been confined to a proportion of the podocarp element and the broadleaved hardwood canopy is often largely intact. Where this is the case the management goal should be to encourage sufficient podocarp recruitment, naturally or by planting, to gradually restore the podocarp presence in the forest. The restoration of the podocarp element of the forest will require careful selection of planting sites and possibly silvicultural treatment of competing broadleaved hardwoods.

If a high proportion of podocarps has been previously removed, any future harvest should be confined to recovery of windthrow and dead trees with provision for maintenance of forest structure and habitat.

BEECH FORESTS

In beech forest, diameter growth of individual stems and forest hygiene may be maintained by undertaking thinning of sapling and pole stands. Unduly heavy thinning should be avoided though, as this may destabilise the stand and increase its vulnerability to damage from snow, wind, etc. Two or perhaps three relatively light thinnings are likely to achieve better results than one or two heavy thinnings. Heavy thinning can affect tree form and encourage the development of heavy branching. While costly in relation to the time frames involved, light thinning and pruning of selected stems can be a useful way of encouraging a young regenerating stand back to a more productive state in terms of stand volume. Wardle (1984) describes a number of beech tending regimes. Thinning treatments should be accompanied by actions to reduce the availability of suitable brood material to avoid pinhole beetle build-up (see material under Goal 5.2).

Proposed tending programmes (timing, density/spacing) for any forest type should be documented in draft SFM Plans. Thinning provisions (where relevant) will be contained in approved SFM Plans.

Standard 2.4.3.1 (see page 24) sets requirements of proposed tending regimes in terms of silvicultural objectives and description in SFM Plans.

CRITERION 3

MAINTAIN THE ABILITY OF THE FOREST TO PROVIDE NON-DIMINISHING HARVESTS

SFM PLANS

GOAL 3.1: RESOURCE INFORMATION IS SUFFICIENT IN COVERAGE, ACCURACY AND PRECISION

SFM PERMITS

GOAL 3.1: RESOURCE INFORMATION IS SUFFICIENT

The ability to manage the harvest of timber and other products and amenities of any forest at sustainable levels in perpetuity requires a good understanding of the forest, based on detailed inventory and forest description. Not only is it necessary to have a clear picture of the forest resources present, but it is also important that the variation in the forest, determined by ecological history, natural disturbance regime or anthropogenic (human-induced) history, is well understood. It may be that a range of forest types occur on a single property and require application of different management systems and practices to ensure their long-term viability.

The Forests Act does not require formal inventory for the purpose of SFM Permit applications. However, MPI must be satisfied that:

› the timber resource present is sufficient to meet the volume prerequisites set down in the Forests Act, Section 67M;
› the forest description is adequate to identify key flora (and fauna) and enable specification of any measures necessary to

retain or enhance these.

SFM PLANS

INDICATOR 3.1.1: INVENTORY OF VOLUME, DENSITY AND SIZE CLASS BY FOREST TYPE AND SPECIES

SFM PERMITS

INDICATOR 3.1.1: APPRAISAL OF VOLUME AND SPECIES (ESTIMATE ONLY, REQUIRED OF VOLUME BY SPECIES)

The Forests Act recognises two levels of information in describing forest resources: the forest type, and individual timber species.

FOREST TYPES

Newsome (1987) describes eight major vegetation types ("vegetative cover groups") containing numerous "vegetative cover classes". Within the forest group, six major forest types broadly describe most (approximately 5.5 million hectares) of New Zealand's intact indigenous forest. (Newsome's "broadleaved" species are synonymous with "broadleaved hardwood species" referred to in the Forests Act.) The six forest types are:

1. **Podocarp forest:** Present in both North and South Islands, this type is concentrated on the eastern and western margins of the volcanic plateau and on flat and undulating glacial outwash terraces in Westland. Rimu usually dominates this tall forest type, with miro, matai, totara, silver pine and kahikatea. Kahikatea dominates in swampy flats. Associated subcanopy species include hinau, quintinia and a variety of shrub hardwood species, epiphytes and lianes.
2. **Podocarp–broadleaved forest:** Largely confined to hill country, the podocarps, often dominated by rimu, with matai, miro, totara and kahikatea, are less dense and appear as emergent crowns over a closed canopy of broadleaved hardwoods. Northern

rata or southern rata are often present among the emergent podocarps and in the far north, kauri is locally prominent. Depending on locality, the broadleaved hardwood species may include tawa, kamahi, rewarewa, hinau, taraire, pukatea, maire and towai.

3. **Podocarp–broadleaved–beech forest:** This type is a prominent element of the forested ranges from the Kaimai Range to Fiordland. It occurs in regions of medium to high rainfall. These are tall-stature forests with emergent crowns of podocarps above a closed canopy of mixed broadleaved hardwoods and beeches. In inland Taranaki the beech element of the forest (black and hard beech) is confined to dry sandstone ridges while beech in the forests of north-west Nelson (typically red, silver, hard and black beech) is distributed throughout the forest.
4. **Beech forest:** All five of the beech species (red, silver, hard, mountain and black) occur in this type in greater or lesser proportion. Beech forests may consist of one species, e.g. black beech in the eastern Canterbury foothills, and mountain beech in the main ranges. At lower elevations, usually in areas of medium rainfall, red–silver beech forest is an important association. In the Buller and north-west Nelson, hard beech, either as pure stands on westerly faces or in a mixture with the other beech species, is an important element of the forest.
5. **Beech–broadleaved forest:** Beech–broadleaved forest occurs in forested lowland and montane foothills and ranges from the Kaimai Range in the north to Fiordland, but it only attains prominence in a few localities. Black, hard, silver and red beech species form associations with rewarewa, kamahi, hinau and southern rata. Tawa is present in the forests from Marlborough north, while red and silver beech are important elements of the type further south, with southern rata, quintinia and pokaka.
6. **Broadleaved forest:** Broadleaved forest is present in the high

rainfall areas of the North and South Islands. In the North Island it is important on the foothills of the ranges and in the South Island it is an important type on the mid-slopes of the ranges within the "beech gap" of central Westland, where the beeches are naturally absent. In the northern North Island important species are tawa, taraire, puriri, and rewarewa with kamahi, hinau, towai and mangeao. Further south tawa and kamahi dominate. Broadleaved forest occurs above the podocarp-broadleaved forest of the lower slopes in central Westland and is dominated by kamahi, southern rata and quintinia, with Hall's totara and kaikawaka.

Seral and regenerating forest

There are numerous scrub and mixed forest-scrub types, including kauri–manuka–kanuka, regenerating broadleaved forest and manuka–kanuka scrub. These may occur on land considered for management under Part 3A of the Forests Act.

Generally the types listed above will serve as a suitable broad classification for the purposes of the Forests Act. In describing specific forest areas for the purposes of planning and management, however, it is desirable that these type descriptions be refined in terms of the detail derived from forest inventory or appraisal.

TIMBER SPECIES

Identification of names (and species) of timber trees and tree ferns proposed to be harvested, along with sufficient information to justify proposed harvest level(s) must be available from forest description and inventory/assessment.

> **Standard 3.1.1.1** (see page 25) sets the minimum information needed about species proposed for harvest.

In order to successfully manage and perpetuate a species within a forest it must be well described, both in terms of the resource present, and its ability to replace itself on a given site. Forest inventory, properly planned and executed, along with information on growth rates, can provide the data required to estimate sustainable rates of harvest.

There are two inventory types that provide useful baseline information:

1. **Forest reconnaissance** is a method for describing forest composition and typing forests. The forest reconnaissance method involves qualitative description of the forest, in terms of the species present (timber trees and non-timber species), their relative frequency across the range of height classes, and site characteristics that may serve as indicators of the importance of species and species' groups on different sites. Fauna presence (native birds, reptiles etc.) and wild animals (and signs of their presence/impacts) in the forest are also recorded.

   This type of forest sampling system has been used throughout New Zealand's Crown-owned forests by government agencies. Analysis of such descriptions has been used to classify indigenous forests into forest associations, or types. Forest reconnaissance methodology is described in Allen (1992). This publication may be purchased from Landcare Research, info@landcareresearch.co.nz.

   Descriptive information relevant to private forest areas may be available through the DOC and in the National Vegetation Survey database at Manaaki Whenua Landcare Research New Zealand Limited, Waikato and Lincoln. Also, information collected by territorial authorities as part of Resource

Management Act Section 6C work will be directly relevant to landholdings.

Standard 3.1.1.2 (see page 25) defines forest description information required.

2. Inventory of tree species: In a podocarp–broadleaved hardwood forest the dominant species may be broadleaved hardwoods of limited commercial timber value. While it is not necessary to quantify the timber volumes of species that will not be managed, it is advantageous to obtain a measure of their site occupancy in relation to commercial species. It may, for example, be justifiable to undertake silvicultural treatment of non-commercial species to ensure the replacement and recruitment of the commercial species where this is consistent with natural patterns. The measurement of diameter and derivation of size-class distributions and basal areas for non-commercial species are useful indicators of their status and enable conclusions to be drawn about their likely future impact on forest management.

Standard 3.1.1.3 (see page 26) specifies assessment coverage for tree species in forest description(s).

For commercial species additional information must be collected. This may be limited to measurement of their total stem height so that with measurements of diameter the total volume of individual stems within a sample can be read off a tree volume table or calculated using a tree volume equation. For a detailed guide to tree and log measurement, refer to *Measuring Indigenous Trees and Logs – A Field Guide* (MPI, 2013).

The minimum timber measurements required, by species, are diameter at breast height (1.4 metres above ground level) with deduction as appropriate for visible abnormality (excessive butt swell, fluting/flanging) that renders any section of a tree bole (or toplog) unmillable, and the height of the main stem of the tree to a predetermined top diameter (usually 15 centimetres, or the point at which the main stem branches into the crown). Minimum diameter at breast height for stems to contribute to total merchantable standing volume is generally 20 centimetres for beech species and 30 centimetres for other species. Minimum length (height) for all species is 2.5 metres.

For toplogs to contribute to total merchantable standing volume, minimum dimensions are 15 centimetres small end diameter with 20 centimetres centre girth diameter (determined from measured centre girth where possible for felled logs, or by an estimate of diameter at point of centre girth for toplogs in standing trees), and minimum length of 2.5 metres.

While volume estimates obtained from the measurement of diameter and height may not indicate the recoverable volume of commercial timber (except for species groups such as the podocarps that are often straight and relatively defect free), such measurements enable a variety of information to be presented from a sample of commercial and non-commercial trees as a component of forest type description(s) and give sufficient information for the planning and control of timber harvesting.

"Double sampling" (otherwise known as "two-phase sampling") is sometimes undertaken to improve the coverage of an inventory yet maintain costs at a manageable level. This involves conducting a large sample of a simply measured variable to a high level of precision (e.g. basal area or stem density by diameter, by horizontal point sampling or line sampling respectively) and measuring a sub-sample of additional variables (e.g. height, diameter and species of timber trees counted as "in"). The relationship between basal area (or stem density by diameter in the case of horizontal line sampling) and volume is then established by regression analysis and the results from the sub-sample applied to the larger sample to give estimates of parameters such as stand density and volume on a species by species basis. While this is an economical method of improving the efficiency of inventory, it requires a good understanding of forest inventory and statistics. (Refer Hammond (1995), Goulding and Lawrence (1992) and Colley (2005).)

Unless volume equations have been constructed for a specific forest, the Ellis *Tree Volume Equations for the Major Indigenous Species in New Zealand* (Ellis, 1979) are a good basis for calculating stem volumes. The equations (or tables) likely to be required are those for mature kauri, mature rimu (use for all podocarps), mature tawa (use for all broadleaved hardwoods), and mature beech.

Standard 3.1.1.4 (see page 26) sets the minimum timber measurements necessary.

Tabulated information on species' size-class distributions, including regeneration and advanced growth (seedlings, saplings and poles) within forest types enable conclusions to be drawn about the past regeneration and recruitment (growth) from one size class to another. This information, in conjunction with known growth information will assist the development of management strategies designed to maintain adequate stem densities within size classes, fundamental to maintenance of stand structure and natural values.

Standard 3.1.1.5 (see page 27) gives requirements for tree size-class information.

Standard 3.1.1.6 (see page 27) gives regeneration information necessary for inclusion in forest descriptions.

Data analysis and presentation

In combination with analysis of size-class distribution data for individual species, basal area provides an indication of stand development and site occupancy by comparison with documented information for similar forest types. For example, Wardle (1984) provides a table of mean basal areas for a range of beech forest types, based on many plots measured over many inventories. Interpretation of such information may influence choice of silvicultural systems and the derivation of harvest rates for the species present.

Estimation of recoverable sawlog volume (as opposed to total stemwood volume of merchantable dimension), while important to the owner from a commercial perspective, is not a necessary prerequisite for draft SFM Plans. If inventory includes assessment of timber in quality classes (e.g. veneer, sawlog, industrial wood), it is recommended that this information be summarised in draft SFM Plans.

Equally importantly, the inventory specifications should be consistently applied in later operations, such as measuring the volumes of stems selected for harvest (harvest regulation). This is irrespective of any other measuring system used by the owner (e.g. to calculate recovered volume at skid or to ensure load volumes/weights meet specifications for helicopter extraction).

For some landowners, part of the harvest may consist of smallwood (e.g. prepared firewood from dead trees or waste) and the only practical way of measuring this part of the timber harvested from the forest may be by weight. However the initial inventory should be in terms of stand volume and where the harvest is controlled by scaled weight it should be converted back to standing volume equivalent for forest records.

Standard 3.1.1.7 (see page 28) prescribes volume definition and species' volumes required of forest inventory and/or forest appraisal/description.

Standard 3.1.1.8 (see page 28) requires inventory description in SFM Plans and defines MPI forest appraisal methods that may be used in confirming forest descriptions and assessing forest volumes for SFM Permits.

SFM PLANS

INDICATOR 3.1.2: INVENTORY ACCURACY AND PRECISION

SFM PERMITS

INDICATOR 3.1.2: FOREST APPRAISAL ACCURACY AND PRECISION

Generally, inventory (and forest appraisal) will involve the random location and measurement of sufficient sample plots to cover the variation within the forest (forest types, altitudinal range, aspects). The number and size of sample plots required will depend on the degree of variability within the forest.

There are many forest sampling methods that may be applied. They may be undertaken on a systematic, random or stratified random basis and include fixed area sampling and sampling with probability proportional to size (a commonly used example of the latter applies the use of a split prism to estimate basal area and/or stand density). Each sampling method has specific advantages and disadvantages. Some may be more efficient to apply than others in certain circumstances. The outputs required from inventory should be identified before the inventory method is chosen.

Achieving limits of error of less than ±20 percent in indigenous forests may require a high sampling intensity.

For species that are of variable distribution and limited frequency within the forest, a secondary sample should be considered. For example, conducting an aerial count of all crowns identifiable in or emerging through the canopy and measuring a random sub-sample of trees to obtain size-class distribution and tree volume information may better sample scattered emergent species such as rimu.

Regeneration (seedlings, saplings and poles) must be assessed in ground-based plots.

Where precision level of an inventory estimate (e.g. volume per hectare) for a species is in the range ±50–100 percent, MPI will be unlikely to approve harvest rates of more than half the potentially sustainable rate. Wide error limits may indicate that the true population mean may be higher or lower than the sample mean and resultant allowable harvests, calculated from such an estimate, may not be sustainable. In some cases a pilot inventory may be desirable to enable the optimum sample size to be determined (refer Goulding and Lawrence (1992)).

For forest areas less than 100 hectares 100 percent enumeration of commercial species may be possible. However this is not normally the case and an inventory based on a sample of the forest is the most common.

Further information on inventory is available in *Indigenous Forestry – Sustainable Forest Management*, Ministry of Forestry and New Zealand Farm Forestry Association (1998), and in Goulding and Lawrence (1992).

Forest inventory is a specialised field. Landowners should seek advice on inventory from a forestry professional.

Standard 3.1.2.1 (see page 30) specifies information needed to indicate reliability of forest sampling estimates.

Standard 3.1.2.2 (see page 30) sets the approach applied by MPI in determining harvest rates.

PREDICTING SUSTAINABLE RATES OF HARVEST AND ESTABLISHING INITIAL HARVEST RATE(S)

Establishing reliable sustainable harvest rates for mixed species forest managed on a continuous cover basis is difficult. It requires a number of assumptions from the outset, and the less information available at the beginning, the more initial growth estimates must rely on a range of assumptions.

For instance in the absence of detailed information, assumptions have to be made regarding regeneration recruitment, growth and mortality. On top of this the likely impacts of forest management must be understood, or assumed. Added to these uncertainties are the potential effects of management (e.g. harvesting) of one species on other species.

Where inventory results are imprecise MPI will be conservative in "fixing" sustainable harvest rates, at least until repeat measurements of a forest "under management" provides reliable information on regeneration rates, competition, growth and mortality and overall stand volumes.

SFM PLANS

INDICATOR 3.1.3: THE RATIONALE PROVIDED FOR PROPOSED HARVEST RATES

MODELLING FOREST GROWTH TO ESTIMATE SUSTAINABLE HARVEST RATES

There are simple and sophisticated models for estimating sustainable rates of harvest and controlling or regulating the harvest. They make take the form of single-tree and stand growth models, or methods using repeatable forest inventory to monitor and control harvesting in uneven-aged forests.

Stand growth models

Stand growth models use parameters such as size class distributions, stand basal area and standing volume to predict the growth or yield of the forest. They do not rely on details of individual stems in the stand. Such models have commonly been applied to intensively managed, even-aged forests (e.g. plantations). A stand growth model will predict the increase in the parameters of interest (e.g. timber volumes) over a time period.

Single-tree models

This approach uses the individual tree as the basic unit of modelling. The minimum data required may be a list of the diameters of all of the trees in a stand, usually based on a sample. Single-tree models are usually derived for individual species or species' groups where the individual species display similar form.

Whyte and Zhao (1999) provide a basis for modelling diameter growth on a single-tree basis for a number of species in Westland and Southland.

Size-class models

Size-class models divide the stand into two or more size classes. Application of the model requires information on the time taken for a tree to grow from one size class to the next and involves the projection of trees from their respective size classes into the next, using a stand table. The simplest method of projecting the stand table is to use an average growth rate for each size class. Stand increment (growth) for a specified time interval is then calculated by comparing the stand volumes at the beginning and end of the interval. Using such modelling for predicting harvest rates requires assumptions to be made regarding regeneration, growth rates within and between size classes and mortality rates where this information is not available from permanent sample plots (PSPs).

Models for natural forests

Simple stand growth models based on published growth information (e.g. Wardle, 1984) have application in the estimation of sustainable harvest rates. They may be all that is available in the first instance and will at least indicate the range of increments applicable to specific forest types, sometimes on a regional basis. The choice of harvest rates based on documented case studies should take into consideration the management system to be adopted along with details of forest location, inventory, site characteristics and effects of climate. Predictions of sustainable rates of harvest for beech forests managed in coupes have generally been based on simple models that reflect relationships between age and volume, or age and mean diameter, for example.

Single-tree and size-class models are probably the most appropriate for estimating sustainable harvest rates from mixed species, uneven-aged forests. The accuracy of outputs from such models will depend on the availability of reliable estimates of regeneration, recruitment and mortality rates. Single-tree models require "lists" of variables such as the diameter of individual stems in a given forest area while stand table projection is undertaken from estimates of stem density within size classes. Coupled with predictors of height they can be used to estimate changes in parameters such as stand volume over a specified time period.

Methods of continuous forest inventory have been developed that rely on the repeated measurement and recording of individual trees in randomly located permanent sample plots, and derivation of increment rates using computer analysis. Providing sufficient sample plots are established to provide reliable estimates of regeneration, recruitment and mortality, these methods will provide a useful long-term basis for monitoring and managing indigenous forests.

It should be recognised that, at best, models provide an estimate of what might be a sustainable yield of timber. They will require regular updating using the results from permanent sample plot re-measurement, and records of any impacts on forest regeneration, growth and mortality resulting from management activity, primarily harvesting. In other words models should be used within a context of adaptive management.

There may be published species growth information available for comparable forest areas that may assist in the establishment of interim harvest rates. There may also be published research information available for similar forest stands that can provide a basis for comparison and allow some general conclusions to be drawn about the likely increment of the stand relative to that in documented examples. Where information has been obtained from review of published regional growth information or research findings, the minimum level of such information should include, for each major tree species, estimates of: growth rate; diameter distribution; basal area and volume; and estimates of seedling, sapling and pole densities.

It is likely that for most forests, initial management proposals will be based on simple stand models.

SIMPLE YIELD REGULATION

Some simple methods of establishing initial harvests and regulating "yield" are given below.

Area methods

These involve dividing the forest into a number of equivalent "compartments", and harvesting timber over a predetermined "felling cycle" from one compartment each year. The maximum volume to be harvested is determined by the area and "rotation" length such that:

$$Y = A/R$$

where:

Y is the annual harvestable area;
A is the total forest area;
R is the rotation length of the species concerned.

The annual yield is then dependent on the stand volumes present.

This method is most suited to even-aged, single species management where the optimum felling age is determined by modelling existing stands under management, and is not recommended for most natural forests. It may have application for beech management in even-aged coupes (clear cuts of a predetermined area).

Rotation length is not applicable in uneven-aged, natural forests but using known information regarding average species longevity, or the time required for stems to reach a predetermined size, a broad estimate of *R* can be made. Some information on species longevity and age-class distributions is found in Katz (1980, unpubl.), Ogden and Stewart (1995), Smale *et al.* (1986), Norton *et al.* (1988) and James and Fraser (1999).

Volume and increment methods

The Austrian formula, developed in 1811, adopts the notion of a normal or maximum attainable level of growing stock, represented by, for example, stand volume, and where the stand under management does not represent the ideal state (perhaps the forest has been overcut or subject to natural mortality). By introducing actual increment and selecting a period over which the forest will be encouraged to gradually return to the normal state, the formula will compensate, or trade off yield against future growth.

$$Y = Ia + \frac{AG - NG}{P}$$

where:

Y is the annual yield (volume);
Ia is the actual volume increment, usually determined on the basis of mean annual increment;
AG is the actual growing stock (volume);
NG is the "normal" or maximum attainable growing stock (volume);
P is the period of adjustment (sometimes set at the rotation length).

This formula must be used with caution. A forest with a high proportion of young stands will have high rates of increment (and *AG* – *NG* will be negative), and a forest with a comparatively high proportion of old stands will have a comparatively low increment (and *AG* – *NG* will be positive and high). As a result, application of the formula tends to oppose and delay the rate of adjustment.

Gerhardt's formula, a modification of the Austrian formula reduces this effect:

$$Y = \frac{(Ia + In)}{2} + \frac{AG - NG}{P}$$

where:

In is the ideal or normal increment.

The Austrian and Gerhardt's formulae assume all stands can be ideally stocked. This is unlikely to occur throughout the forest given variable site and stand conditions, so it is advisable to adapt the formula such that *NG* and *In* are "desirable" or practically attainable, rather than ideal and unlikely to be attained on all sites in practice. This involves a proportional reduction to tree growth models to, say, 90 percent of the ideal, or development of stand-based models that reflect this variability. Thus Gerhardt's formula becomes:

$$Y = \frac{(Ia + Id)}{2} + \frac{AG - DG}{P}$$

where:

Id is the desirable increment;
DG is the desirable growing stock.

The selection of the proportional reduction to represent the likely attainable increment is subjective but must take account of sites that are either unproductive or where forest growth is limited (e.g. dry spurs, slips, steep unmanageable gorges, poorly drained areas).

The selection of the period of adjustment, if manipulation of the forest structure is desirable, is an important consideration. If no previous modification to the forest has occurred there may be no need to consider manipulation of forest composition, structure or stand volumes. Then, $Ia = Id$, $(AG - DG)/P$ is zero and the maximum attainable annual yield is equivalent to Ia (the current annual increment).

On the other hand, where there has been previous harvesting of, say, rimu, in a mixed rimu-broadleaved hardwood forest, there may be justification to apply an adjustment period. Given that there is no “rotation” in uneven-aged selection forestry, the selection of an adjustment period must be based on known data such as existing size class distributions and estimates of mean diameter increment.

GROSS INCREMENT VERSUS NET INCREMENT

The basic models listed above are simple stand models. They assume natural mortality is zero and the resulting yield predictions represent the live timber available for harvest.

In natural uneven-aged forests that are relatively stable, natural mortality over long intervals is likely to be in approximate balance with recruitment (trees growing to measurable size) and survivor growth (growth of surviving trees over the measurement period) so that:

Gross Increment (total wood production) = Mortality + Recruitment + Survivor Growth

In unmanaged natural forests over long time periods, the change in live wood volume (net increment) is likely to be zero. Where trees are selected for harvest on the basis of their predisposition to windthrow or death, using indicators such as stability, crown dieback or stem decay, it may be possible to anticipate a proportion of the future mortality and over time maintain forest increment and natural processes including mortality.

The greatest potential to increase growth and limit natural mortality lies with the management of light-demanding species such as beech in even-aged coupes. Timely thinning reduces competition between individuals, enhances diameter growth and minimises natural mortality. Thinning ought to be carried out where it is not detrimental to natural ecological processes. Final harvests are undertaken before trees become old and subject to natural mortality. Where forests are managed on this basis it may be necessary to set aside representative areas (where any forest type or types are not well represented in protected areas in the region).

For beech managed as even-aged groups or coupes, simple stand models predicting yield at a future time can be constructed on the basis of measured diameter, height and volume increments for a site, with management according to a predetermined silvicultural regime (thinning, pruning and harvest schedule).

However, much indigenous forest, including beech forest, has considerable potential for sustainable production under various types of selection systems, while retaining natural values.

For forests more suited to continuous cover, uneven-aged management, natural mortality is likely to comprise a significant component of forest replacement so that the anticipation and management of mortality (identification, recovery and utilisation of trees predisposed to windthrow or natural mortality) is likely to constitute a significant proportion of future timber harvests.

The recovery of at-risk, dead and windthrown trees is recognised in the silvicultural prescriptions contained in the Second Schedule to the Forests Act (accepting the need to retain habitat trees).

A realistic rate of harvest for species managed as uneven-aged stands is therefore likely to be no more than the average rate of natural mortality (equivalent to half the gross increment of the forest), assuming forest management practices do not compromise forest replacement and recruitment processes. Application of formulae like Gerhardt's formula, when used in conjunction with estimated gross increment, should include a factor to represent a realistic realisation of gross increment. This factor will vary depending on forest size, intensity of forest management, ability to predict imminent mortality, and durability of the timber of the species under management. Restricting the harvest to 50–60 percent of gross increment provides allowance for background natural mortality that is not recovered.

SPECIES WITH DISCONTINUOUS SIZE CLASS DISTRIBUTIONS

While most beech species and a number of the broadleaved hardwood species are often well represented across the range of size classes over relatively small areas, and lend themselves to equal annual harvests (accepting natural events), some other species such as the podocarps often have gaps in their size-class distributions.

Rimu in hill country forests is often present as medium and large size trees, with relatively little seedling and sapling advance growth or recruitment of poles and small trees. In some forest areas the trees may be old and the rate of mortality may exceed growth. In these circumstances the selection of a period of adjustment (whereby a proportion of increment is retained as increased growing stock over this period, rather than taken out as a component of allowable harvest), to allow the replacement of mature trees (from natural regeneration and/or planted stock), and the maintenance of forest structure is the primary aim.

For podocarp species in particular, the period of adjustment is likely to be quite long (e.g. 200–300 years) and will have a significant effect (reduction) on harvest rates. If too long, however, the natural rate of mortality may be substantially higher than the estimated allowable harvest rate, even allowing for the retention of a proportion of moribund and dead trees for habitat purposes.

It is also possible that standing forest volumes may decline (irrespective of the level of harvesting) over the period required for advanced growth to be progressively recruited into the tree size classes. In these circumstances a significant proportion of the annual harvest may comprise windthrown, dead or dying trees.

Standard 3.1.3.1 (see page 31) requires growth rate information to support proposed harvest rates in SFM Plans.

Standard 3.1.3.2 (see page 31) provides for conservative harvest rate determination in the absence of forest-specific data.

SFM PLANS & PERMITS

GOAL 3.2: HARVESTS DO NOT EXCEED RATES OF SPECIES/ STAND REPLACEMENT

SFM PLANS & PERMITS

INDICATOR 3.2.1: HARVEST RATES BY SPECIES

Specified harvest rates, by species and in total for the forest, will be determined on the basis of inventory analysis and available growth rate information in the case of SFM Plans, and on estimates of standing volume from forest appraisal (and any inventory if undertaken) in the case of SFM Permits.

Maximum permitted harvests under approved SFM Permits are not determined on the basis of forest growth but are arbitrary and intended to provide owners who do not wish to commit to a long term SFM Plan with an economic one-off harvest.

Note that where a slow growing species (e.g. rimu) is harvested under an approved SFM Permit to the full 10 percent of the standing resource of the species, renewal of the SFM Permit will not be possible until the forest has replaced, through growth, the timber removed. This may not be for a number of decades.

Sources of information on growth rates for indigenous species include:

Beech	Wardle (1984); James and Fraser (1998); Dalley and Richards (1999); James and Fraser (1999); Whyte and Zhao (1999)
Rimu and other podocarps	Norton *et al.* (1988); Katz (1980); James (1998); James and Norton (2002); Smale *et al.* (2004)

Tawa	Smale *et al.* (1986)
General	Ogden and Stewart (1995); Whyte and Zhao (1999).

These and other publications provide general information and in some instances results specific to research and management trials. They provide a general guide to the range of growth rates achievable in both natural and managed forests, but should be interpreted with care if applied to specific forest areas.

Standard 3.2.1.1 (see page 32) specifies the way harvest rates are set for SFM Plans and SFM Permits.

SFM PLANS

FELLING CYCLE

Indigenous forest growth rates are low compared with plantation forests (on average less than five cubic metres per hectare per annum for most indigenous species and about 20 cubic metres per hectare per annum for some plantation species, e.g. *Pinus radiata*). As a result, sustainable annual harvest rates are likely to be too low to enable efficient forest harvesting and management over the entire forest area every year; for example a tawa forest may exhibit gross increment, inclusive of natural mortality, of say, 2 cubic metres per hectare per annum, and sustainable rates of harvest may be less than half this figure.

In these circumstances it may be more practical, in the interests of economic management and to avoid frequent forest disturbance, to divide the forest into a number of operational areas, or compartments, and concentrate annual harvests on successive compartments over the felling cycle.

For example, a 1000-hectare tawa-dominant forest, with a 0.5 cubic metre per hectare per annum allowable harvest, may be best managed by dividing the forest into, say, 10 compartments of equivalent forest volume. The annual allowable harvest of 500 cubic metres is taken each year from successive compartments (harvesting 10 times the annual allowable harvest (5 cubic metres per hectare) for that compartment once every ten years) so that after the ten-year felling cycle is completed, the entire forest area will have been subject to one harvest operation.

The felling cycle should not be too long since this has the effect of increasing the proportion of the forest harvested per hectare in any one harvesting operation. This, taken to extremes, results in the forest developing as a small number of even-age classes, and the forest structure becomes significantly modified. For some species (e.g. tawa), forest replacement processes may also be interrupted, resulting in a gradual reduction of increment.

Generally, stand structure should be maintained by selecting trees across a range of size classes, rather than concentrating harvests on the largest trees. This may be difficult in those forests where the commercial species are predominantly mature to old (e.g. hill country rimu forest).

Standard 3.2.1.2 (see page 33) establishes the components and limits of fixing and implementing any felling cycle.

SFM PLANS

PERIODIC HARVESTS

There are occasions when landowners, because of fluctuating market conditions or other considerations, may elect to delay or increase harvesting operations over a period. This can be accommodated through provisions for periodic harvests.

Landowners may elect to take the entire harvest for a period in one operation. Usually the period is set so that the periodic harvest will not have a detrimental impact on the forest, but allows a degree of flexibility in forest management. For example a periodic harvest for rimu in a mixed rimu–tawa forest may be ten years, permitting the maximum harvest for a ten-year period to be uplifted in year one, followed by nine years without rimu harvesting.

Periodic harvests are limited as to the length of the period. Periodic harvests will not be approved if they are likely to exceed the volume/area rates (10 percent for beech and 5 percent for kauri, podocarps and shade-tolerant, exposure-sensitive broadleaved hardwoods).

Landowners are required to maintain records of harvests (by species) undertaken from forest areas. These provide a check of harvest rate and periodicity, and may also be compared with sawmill records supplied to MPI under regulation. MPI may also inspect harvest sites and review measurement practices employed by the owner and/or forest contractors.

Standard 3.2.1.3 (see page 34) requires harvest records and compliance with approved harvest rates.

SFM PLANS & PERMITS

INDICATOR 3.2.2: HARVEST OF DEAD TREES AND NATURALLY OCCURRING WINDTHROW

The presence of dead standing trees and naturally occurring windthrow is a common feature of natural forests. Mortality of standing trees occurs as a result of either competition in young, highly stocked stands (sometimes combined with insect or fungal attack), or of the decline and death of old trees and due to climatic events e.g. earthquakes, drought and major snow storms. In the latter case, more durable species will contain sound timber that can be recovered.

While natural mortality should be taken into account when establishing the gross increment of the forest, where practicable, it should be recovered in preference to felling live trees. However, retention of a proportion of moribund or dead standing trees may be necessary to maintain habitat requirements for important flora or fauna species. Similarly, the retention of a proportion of windthrown trees may be desirable to maintain forest nutrient turnover and plant replacement processes.

Retention of a proportion of large old trees is also a component of maintaining stand structure. Absolute densities of stems retained to grow old and complete their life cycle should be determined for individual stands based on their composition and structure.

Standard 3.2.2.1 (see page 35) sets requirements of harvesting in terms of maintaining forest natural values and timber recovery (dead or windthrown).

SFM PLANS & PERMITS

GOAL 3.3: HARVESTING IS IN ACCORDANCE WITH APPROVED ANNUAL LOGGING PLANS

SFM PLANS & PERMITS

INDICATOR 3.3.1: HARVEST RATES BY SPECIES, HARVEST LOCATION AND OPERATIONAL PERFORMANCE

An Annual Logging Plan must be submitted to MPI for each year that a harvest (or other forest management operation) is proposed and must be approved prior to work in a forest area being undertaken. Annual Logging Plans must comply with the Second Schedule of Part 3A of the Forests Act. This schedule requires any

Annual Logging Plan to specify the area proposed to be harvested and harvest volumes by species; indicate locations of roads, tracks and landings, both existing and proposed; show waterways; describe topography; and specify proposed methods of harvesting and any special logging requirements.

Quality mapping and/or aerial photography is fundamental to forest management planning. The area to be subject to harvesting, and access, waterways and topography should be marked on a topographic map scale 1:25 000 to 1:10 000, or provided as a shapefile, gpx file or kml file projected in NZTM.

Trees selected for harvest should be marked, measured and recorded by species prior to harvest. This enables the regulation of the harvest to within approved levels. While the prepared logs removed from the forest may be scaled (measured), for the purposes of transport and sale, the harvest quantity must be based on the same units of measure applied in the forest inventory. In other words, the standing volumes of all trees selected (and subsequently harvested) should have diameter and height measurements recorded using the specifications adopted for the forest inventory or appraisal. By keeping a running total of the volume of each species as they are selected, the allowable harvest should not be exceeded. MPI may require submission of a “felling list” detailing species, diameter at breast height, height, volume and Global Positioning System (GPS) location of trees selected for harvest.

It is also desirable that felling direction be indicated on the trees selected for harvest. Tree marking is best undertaken with weather and fade resistant paint or crayon specifically developed for surveying and forest management.

Tree selection is a process requiring skill and experience, both in understanding the best silvicultural treatment for the forest and in understanding the constraints within which tree-fellers are required to work. The decision to fell a marked tree (in terms of safety) ultimately rests with the tree-feller.

Where industrial or other smallwood forms a part of the annual harvest, harvest control may be on the basis of scaled weight converted to standing volume equivalent for reporting purposes. This conversion of alternate measure to standing volume equivalent must be by use of a factor shown to be appropriate and specific to the product concerned. *The Indigenous Timber Table of Metric Cylinder Volumes* (MAF, 2007) contains average volume/weight conversion factors for most commercial indigenous species. These should be used in the absence of regional or forest-specific factors.

MPI may inspect forest areas prior to approving Annual Logging Plans. This is likely to be coupled with inspection and review of the previous year's harvest. MPI may also request amendments to Annual Logging Plans and require that all trees to be harvested be marked and recorded, and directional felling techniques employed to minimise forest damage. Alternatively, MPI may mark the trees to be harvested.

MPI may undertake a forest inspection prior to approving an Annual Logging Plan to confirm compliance of the proposed operations (including tree selection) with the Act. Operational activities (including harvest sites) carried out under an approved Annual Logging Plan may also be inspected to confirm compliance using methods set out in standard operating procedures developed and maintained by MPI.

Standard 3.3.1.1 (see page 36) details the requirements for, and of, Annual Logging Plans.

Standard 3.3.1.2 (see page 37) gives the requirements for specifying harvest volumes for Annual Logging Plans, and in harvest control.

Standard 3.3.1.3 (see page 37) provides for tree retention, selection, measurement and recording as harvest preparations.

Standard 3.3.1.4 (see page 37) requires adherence to Annual Logging Plans.

SFM PLANS

GOAL 3.4: SUSTAINABLE FOREST MANAGEMENT PLANS ARE REVIEWED AND AMENDED AS REQUIRED TO ENSURE COMPLIANCE WITH PART 3A OF THE FORESTS ACT

SFM PERMITS

GOAL 3.4: SUSTAINABLE FOREST MANAGEMENT PERMITS ARE REVIEWED AND AMENDED AS REQUIRED TO ENSURE COMPLIANCE WITH PART 3A OF THE FORESTS ACT

The Forests Act empowers MPI to review and amend SFM Plans and SFM Permits where a natural event or an act constituting an offence against the Forests Act:

› reduces the amenity or natural values in the forest; or
› reduces the indigenous timber standing in the forest; or
› otherwise renders the Plan inoperative.

An offence can include wilful damage to indigenous timber in an area subject to a registered SFM Plan or Permit, and contravention of any provision of a registered SFM Plan or Permit.

Where a natural event or an act constituting an offence against the Forests Act renders an SFM Plan or Permit inoperative, MPI may review the SFM Plan or Permit and may require amendments to it. After consultation with DOC, MPI may vary or, by agreement with the landowner, cancel the notification (i.e. the registration) of an SFM Plan or Permit.

SFM PLANS & PERMITS

INDICATOR 3.4.1: EFFECTS OF MAJOR NATURAL EVENTS (E.G. WINDTHROW, SNOW DAMAGE, EARTHQUAKE)

Many forests undergo periodic major change as a result of exceptional storms, drought and earthquake, often exacerbated by subsequent insect and fungal attack. This is a relatively common feature of change in beech forests. Further, the severity of the impact may be influenced by the age-class distribution of the stand, particularly the frequency of old, large trees.

Some forests, on the other hand, undergo gradual change as individual species, in the absence of continuous regeneration and recruitment, mature and begin to die and be replaced by other species. This trend is evident in some podocarp–broadleaved hardwood forest, where the age-class distribution of podocarps (e.g. rimu, matai and totara) is often heavily skewed towards older trees. Regeneration, while it continues to occur at low levels, does not appear to be sufficient to replace the relatively dense mature stands. There is evidence (Norton *et al.*, 1988) that catastrophic disturbance (e.g. volcanism, earthquake, fire, etc.) is often a necessary prerequisite for a successive podocarp regenerative phase.

Given that events causing major change to forest composition and structure are not predictable, the Forests Act provides for review where the basis of establishing management systems and harvest rates has been significantly altered.

In the event of substantial mortality occurring after a natural event, there may be a short-term opportunity to salvage a proportion of the timber lost as a result. The corollary of this is that future harvest rates will need to be reviewed and adjusted downwards to enable forest recovery to occur. In such an event MPI will review an SFM Plan in consultation with the owner and DOC.

MPI may also review a SFM Permit if a natural event results in a significant loss of standing volume before any harvesting has taken place, and where the volume lost is not, or cannot practically be extracted as all or part of the allowable harvest volume. Such a review will be done in consultation with the owner and DOC.

Standard 3.4.1.1 (see page 38) defines circumstances when amendment of an SFM Plan or SFM Permit is necessary because of some natural event(s).

SFM PLANS

INDICATOR 3.4.2: APPARENT EXCESSIVE RATES OF HARVEST OR RESIDUAL FOREST DAMAGE OR INITIAL GROWTH ESTIMATES WERE TOO OPTIMISTIC

SFM PERMITS

INDICATOR 3.4.2: APPARENT EXCESSIVE RATES OF HARVEST OR RESIDUAL FOREST DAMAGE

Updated growth estimates for a forest area could show initial estimates contained in an SFM Plan are unsustainable. Management-induced mortality may also adversely affect sustainability of harvest levels.

Standard 3.4.2.1 (see page 38) defines circumstances when review of an SFM Plan is necessary due to management actions or new information.

Approved rates of harvest take into account anticipated forest increment and the expectation that a proportion of natural mortality will form part of the allowable harvest. Excessive harvests and mortality together may occur where there is:

- a failure to monitor tree felling and keep accurate records;
- a high rate of mortality resulting from harvesting damage;
- deliberate overcutting beyond harvest limits set in an approved SFM Plan (or SFM Permit).

The methods of harvest may be unsuited to the forest type, stand structure or the terrain and result in significant post-harvest mortality, effectively compromising the ability of the forest to continue to provide harvests at the approved level. Alternatively, the level of control of forest operations may be inadequate, or those people undertaking forest operations may require additional guidance and training. The impacts of applying inappropriate methods, or failure to meet sustainable forest management standards may also have an impact on forest health, amenity and natural values.

Standard 3.4.2.2 (see page 39) specifies MPI actions possible to apply to address situations of over-harvest, detrimental operational practices or breaches of approved SFM Plan or SFM Permit provisions.

SFM PLANS

INDICATOR 3.4.3: DISRUPTION OF FOREST REPLACEMENT PROCESSES

The forest under management needs to be monitored to provide assurance that the management systems adopted and the assumptions leading to the establishment of harvest rates are correct. Long-term sustainability relies on the ability of the forest to regenerate and grow, and maintain its composition and structure (comparable to unmanaged forests).

Standard 3.4.3.1 (see page 40) provides for SFM Plan review depending on forest regeneration state.

Standard 3.4.3.2 (see page 40) sets circumstances and timing applicable to SFM Plan review and scope of review/amendments in terms of management systems effects on forest regeneration and growth.

Standard 3.4.3.3 (see page 40) provides for amendment of SFM Plan harvest rates based on forest growth rates, recruitment and management.

SFM PLANS

INDICATOR 3.4.4: FOREST MANAGEMENT PROPOSALS ARE NOT ECONOMICALLY SUSTAINABLE

Like most long-term ventures, indigenous forestry carries with it many risks, not the least of which are those attached to forest health, markets and, ultimately, profitability of forest management. It is critical that landowners have an understanding of:

› the likely value of the timber and other products the forest is expected to produce;
› the likely costs directly involved with selecting, harvesting,

transporting and marketing the timber;
- the likely costs of managing, protecting and monitoring the forest.

The Forests Act does not address the economic viability of sustainable forest management. MPI could not therefore decline approval for an SFM Plan on the basis of a forecast of its likely profitability.

However, economic factors could influence the quality of forest management achieved and therefore the compliance with a registered SFM Plan, and ultimately the sustainability of forest management. MPI, in reviewing draft SFM Plans submitted for approval, may advise landowners where there are concerns that the proposals for management appear uneconomic from the outset.

There are other circumstances where SFM Plans may be reviewed:
- MPI and the landowner may amend an SFM Plan at any time, by agreement;
- MPI, after consultation with the owner and DOC (and Te Puni Kōkiri, in the case of Māori land), may amend and renew an SFM Plan after it has expired;
- DOC may request MPI to review any SFM Plan after five years have elapsed since its approval or last renewal.

The same amendment circumstances listed above apply to SFM Permits.

N.B. No Standard applies under Indicator 3.4.4.

CRITERION 4

RETAIN AND ENHANCE SOIL AND WATER QUALITY

It is a requirement of the Forests Act 1949 that before beginning any forestry activity, a landowner obtains any resource consents required under the Resource Management Act 1991 for that activity.

Landowners should be aware of any marginal strips existing within the forest area, and ensure these are appropriately safeguarded. Necessary permission for access or activities in any marginal strip must be obtained before starting any activity. Similarly, the forest contained within marginal strips does not form part of the forest area contained within any SFM Plan or SFM Permit. Any indigenous trees removed for access or other purposes must be milled under separate authority obtained from MPI. Marginal strips are administered by DOC, under provisions of the Conservation Act 1987.

While the Forests Act requires SFM Plans to specify the relevant details of all applicable District and Regional Plans under the Resource Management Act 1991, this is not mandatory for SFM Permits. Note that does not mean activities conducted under SFM Permits are exempt from any requirements of District or Regional Plans. The Forests Act does require SFM Permit applications (and approved SFM Permits) to specify protection requirements to retain and enhance soil and water quality of the forest area.

MPI field inspections may be undertaken before Annual Logging Plan approval (as post-harvest inspections of a previously approved Annual Logging Plan or as inspections of operations as they are conducted) to assess compliance with Annual Logging Plan provisions relating to retention and of soil and water quality. Forest inspection preparation, fieldwork or follow up may involve MPI liaison with the relevant Regional Council(s), as necessary.

SFM PLANS & PERMITS

GOAL 4.1: IN-FOREST EARTHWORKS (LANDING, ROADING AND TRACKING CONSTRUCTION) DO NOT ADVERSELY AFFECT SOIL AND WATER QUALITY

SFM PLANS & PERMITS

INDICATOR 4.1.1: SITING AND CONSTRUCTION OF EARTHWORKS TO MINIMISE FOREST LOSS, SOIL DISTURBANCE AND MAINTAIN WATER QUALITY

The establishment of permanent access, bridges, fords, landings and temporary tracks relies on a good understanding of the geology and soils, climate, topography and drainage patterns within the forest. All of these factors should be taken into consideration in planning access (whether permanent or temporary), and in choosing harvesting systems, which may influence access requirements.

Draft SFM Plans need to specify the relevant details of the applicable Regional Plan(s). In addition, both draft SFM Plans and SFM Permit applications should include basic rules for the establishment of forest access that are consistent with Regional Plan requirements and that, where applicable, seek to:

- identify areas susceptible to erosion (steep slopes, unstable soils);
- locate accessways on stable, well drained sites (terraces, ridges);
- avoid steep grades and minimise cut-and-fill construction;
- minimise side casting of soils;
- ensure maintenance of natural drainage patterns by installing adequate culverts and run-offs;

- minimise forest loss by ensuring roads and tracks are no wider than necessary;
- limit the number of landings established in the forest;
- avoid stream beds and waterways as access routes;
- maintain adequate riparian margins;
- keep coupe fellings away from poorly drained hollows on steep slopes, as these sites are potential landslide initiation areas.

Retaining site stability and limiting stream sediment loads are key considerations. Construction of earthworks should avoid steep and unstable slopes, with access roads/tracks established some distance (depending on site conditions) from permanent streams to avoid the risk of increasing stream sedimentation. In any event, access establishment must be consistent with rules in the relevant Regional Plan(s).

Standard 4.1.1.1 (see page 42) gives the information to be included in SFM Plans and SFM Permits for intended infrastructure establishment.

Standard 4.1.1.2 (see page 42) gives minimum determinant(s) to assessing maintenance of soil and water values.

Standard 4.1.1.3 (see page 43) provides for riparian zone establishment in relation to forest accessways.

SFM PLANS & PERMITS

GOAL 4.2: FOREST OPERATIONS PROTECT PERMANENT STREAM BEDS AND STREAM AND FOREST MARGINS

SFM PLANS & PERMITS

INDICATOR 4.2.1: LOSS OF RIPARIAN VEGETATION, INCIDENCE OF HARVESTING DEBRIS IN STREAMS, DAMAGE TO FOREST MARGINS

Damage to riparian vegetation and uncontrolled harvesting close to permanent streams can cause harvesting debris to fall into stream beds, resulting in increased sediment loads and disruption of stream flows. Harvesting and roading may also have an impact on stream fauna, especially native fish, many of which are threatened. Maintenance of adequate riparian protection zones in keeping with terrain, soil stability, zone of riparian influence and proposed management systems will generally be required for larger (e.g. three metres or wider) streams in a forest area. In any case, the minimum riparian protection requirements will be defined in relevant Regional Plans and must be implemented.

Where single-tree or small-group harvesting using a helicopter is proposed, it may not be necessary to set aside riparian zones along small streams, unless specified by the relevant District or Regional Plan or as a condition of a resource consent. It may be sufficient to confine tree selection within 20 metres of permanent streams to those able to be directionally felled in line with or away from the stream (unless this contravenes any rule in the relevant District or Regional Plan(s), or would be in a marginal strip).

Where streams are deeply incised or on steep topography it is recommended that harvesting within 10 to 20 metres (depending on site conditions) of stream banks be confined to recovery of windthrow (unless this contravenes any rule in the relevant District or Regional Plan(s) or would be in a marginal strip).

Standard 4.2.1.1 (see page 43) provides for riparian zone management.

Standard 4.2.1.2 (see page 44) gives minimum prescriptions for inclusion in SFM Plans and SFM Permits for stream protection.

Standard 4.2.1.3 (see page 44) sets limits on harvesting close to streams.

SFM PLANS & PERMITS

GOAL 4.3: FOREST OPERATIONS CAUSE MINIMAL RESIDUAL FOREST DAMAGE, LOSS OF GROUND COVER AND SOIL DEGRADATION

SFM PLANS & PERMITS

INDICATOR 4.3.1: GROUND COVER, PONDING, SOIL DISTURBANCE AND/OR COMPACTION AND EROSIVE EFFECTS OF MACHINE USE

Loss of ground cover, soil disturbance, interference with drainage, compaction or erosion due to machine use should, as far as practicable, be confined to landings and accessways. One exception is where planned, controlled scarification is undertaken to facilitate beech regeneration in felled areas.

Where ground-based harvesting and/or log transport is undertaken within the forest, machines should be used that are suited to site conditions and load requirements. Low ground-pressure machines (e.g. wide track, long footprint options) should be used where soil compaction is likely to occur, or where machines are likely to create ruts or interfere with natural drainage patterns.

Where low ground-pressure (LGP) machines are required, recommended ground-pressure upper limits for tracked skidders are:

› D4 or equivalent – 0.35 kilograms per square centimetre (5.0 pounds per square inch);
› D6 or equivalent – 0.47 kilograms per square centimetre (6.5 pounds per square inch).

Other operational procedures to reduce impacts of ground-based harvesting include:

› limiting the number of passes over any track as far as possible to minimise impacts on soils and ground cover;
› avoiding skidding whole tree lengths where there is a risk of damage to edge trees;
› where an edge tree is used as a buffer, removing it at the conclusion of harvesting operations;
› elevating the forward part of loads by an arch or grapple to minimise damage to temporary access tracks;
› siting access tracks so as to avoid poorly drained or low lying areas where the risk of compaction and ponding is high;
› taking precautions to avoid fuel and other chemical spills resulting from machine use.

Care needs to be taken in control of forest operations to ensure no more vegetation is cleared in gaining access, and at harvest sites, than is absolutely necessary. Remedial works to eliminate persistent standing water in depressions or ruts on tracks and maintain drainage that existed prior to tracking – that is, to reduce ponding – may be undertaken at time of operations or as soon as practicable after completion of works, and can reduce effects on the remaining forest. Comparing operational areas with forest untraversed by machine provides an assessment of the scale of operational effects.

Vaughan (1990) provides advice on managing forests to minimise environmental impacts. While he concentrates on operations more applicable to plantation forest management, the general principles and many of the recommended practices are appropriate to indigenous forest management.

Standard 4.3.1.1 (see page 45) details operational constraints to limit impacts on vegetation, soil and water.

CRITERION 5

MAINTAIN FOREST HEALTH AND PROTECT THE FOREST

Weed and pest species, uncontrolled, have the capacity to reduce the diversity of indigenous flora and fauna species, limit regeneration of forest gaps and interfere with natural forest replacement processes. Many plant species (e.g. mistletoes, palatable shrub species, rata and kamahi) are vulnerable to possums, and goats and deer can reduce the diversity of the forest understorey. Birds (including their eggs and young in nests) are vulnerable to attack by predators (mustelids, rats and possums). Wasps prey on native invertebrates, reducing food sources for insectivorous birds. Introduced plants, such as old man's beard (*Clematis vitalba*), can smother the forest canopy. The control of these organisms is fundamental to maintaining healthy, functioning ecosystems.

SFM PLANS & PERMITS

GOAL 5.1: WEED AND PEST SPECIES ARE CONTROLLED

Many introduced pest and weed species have the potential to interfere with natural regeneration processes or threaten wildlife values. Likely impacts of weed and pest species in indigenous forest trees include:

› failure of regeneration;
› crown damage;
› loss of ground cover;
› loss of threatened species.

Pest species include possums, goats, pigs, stoats, rats and wild cats. Deer may be a problem in moderate densities, and domestic stock may cause localised soil compaction, trampling and browse damage where the forest is accessible. A wide variety of weeds can invade harvest sites and access tracks. Similarly, insects and fungi can, separately or in association, cause substantial damage to live trees.

The range of these species and their potential forest impacts are well described in Wardle (1984) and while the focus of this publication is on beech forests, the material is pertinent to other forest types too.

SFM PLANS & PERMITS

INDICATOR 5.1.1: OBSERVED PRESENCE OR SPREAD/INCREASE IN POPULATIONS OF WEEDS AND PESTS

WEEDS

Weeds can impact on indigenous forest by:

› smothering and killing trees (e.g. old man's beard (*Clematis vitalba*), banana passionfruit (*Passiflora* spp.), moth plant (*Araujia sericifera*), Japanese honeysuckle (*Lonicera japonica*), blue morning glory (*Ipomoea indica*));
› suppression of natural regeneration by forming dense cover (e.g. wandering Jew (*Tradescantia* spp.), wild ginger (*Hedychium* spp.), tutsan (*Hypericum androsaemum*), pampas (*Cortaderia* spp.), African Club Moss (*Selaginella kraussiana*), gorse (*Ulex europaeus*), blackberry (*Rubus fruticosis*));
› competition with established trees and shrubs through rapid occupancy of any shrub, sub-canopy and canopy openings especially about forest margins and areas like wetlands (e.g. privet (*Ligustrum* spp.), Darwin's barberry (*Berberis darwinii*), Himalayan honeysuckle (*Leycesteria formosa*) and willow (*Salix* spp.)).

The species mentioned above are examples, not a comprehensive list. Many more common and less common weed species may establish in forest areas, and all have different potential for forest impacts. There is also, in some localities, a risk of shade-tolerant exotic tree species invading indigenous forest (e.g. Douglas-fir). Richardson *et al.* (2005(b)) provide a useful list of weed species that have been recorded in New Zealand indigenous forest.

A wide variety of weeds can invade harvest sites, and many may not be a significant long-term problem at a specific site, especially where single-tree or small-group harvesting is undertaken. Indigenous tree species' seedlings will generally persist within a weed cover and ultimately occupy the site. However, there is a risk of spread from these sites to others, in progression throughout the forest area. Wherever practicable, pre-emptive control should be undertaken to reduce this risk.

The greatest potential for weed problems arises with importation of river gravels (containing gorse seed, for example) for roadmaking, especially into areas at or near forest margins. Seeds are carried into the forest on wheels, tracks or the undercarriage of ground-based machinery, or transferred by animals, especially domestic stock.

Areas where more intense and ongoing weed monitoring and control measures are likely, therefore, are roads, tracks, landings, areas at or near forest margins, and in large gaps created by coupe felling of beech, for example.

Key components to weed management are identified by Richardson *et al.* (2005(b)) and in Ministry of Forestry and New Zealand Farm Forestry Association (1998). These, along with Porteous (1993) are useful references. A summary of key points (drawn from the first two references above) for consideration in forming any weed management and monitoring strategy, follows.

Managing forest margins

A densely vegetated forest boundary can restrict wind dispersal of seed into forest areas. Wild and domestic animals can disperse seed and enhance or maintain conditions suitable for weed establishment and persistence (e.g. by grazing and soil disturbance), yet may also control some weeds, so animal control may be a component to achieving effective weed control. Disturbance to indigenous vegetation should be minimised close to forest margins to reduce sites of possible weed establishment.

Preventing weed invasion in the first place

Once established, weeds can be impossible to eradicate, and costly to control, so minimising the risk of new invasions should be a priority. Machinery should be cleaned down before entering the forest. Gravel for roads and landings should be from weed-free sources if possible. Vehicles, footwear, clothing and hand equipment can carry seed between areas, and so it is prudent to check and clean equipment before moving from one forest area to another.

Considering possibility of weed invasion in selecting silvicultural and harvest systems

Ground-based harvesting carries a higher risk of weed dispersal than aerial extraction due to the ground disturbance involved and also to the higher roading and landing density required. Larger harvest areas (e.g. large-area beech coupes) are also potentially more likely to be colonised by weed species than smaller gaps. Reducing the frequency of harvesting (disturbance) may reduce the likelihood of exotic weeds establishing, even when disturbance areas are small and weed invasions limited to shade-intolerant species – this may be a consideration in selecting felling cycles.

Weed identification and vigilance in forest inspection

Forest owners and personnel working in forests need to be able to identify indigenous species and weeds. While most of the major exotic weeds are easily recognised at an early stage of development, infestations may go unnoticed until well established if regular site inspections are not made. Others may resemble indigenous species at some stage of their life cycle (e.g. pampas looks like toetoe, old man's beard like indigenous *Clematis* species). If there is doubt about any plant discovered in a forest area, advice should be sought as to its weed status. Regional Councils and DOC can identify weed species and provide information on weed control along with local knowledge. With skilled staff, networks of offices and wide contacts, these two bodies are accessible and useful sources of information.

Implementing monitoring and any necessary control measures as soon as possible

As a first step, weed infestations should be regularly recorded and any new, small infestations eradicated wherever possible, as weeds are very difficult to control once established in or near forest. Control measures can include hand pulling or digging, cutting and use of herbicide. Where these methods cannot be used it may be sufficient to remove seed heads from plants and dispose of these outside the forest, e.g. by burning.

Species-specific control information can be obtained through the New Zealand Ecological Restoration Network (NZERN), from Regional Councils or from published manuals such as Porteous (1993). The aim, wherever practicable, is to prevent established weeds from seeding.

Focusing on the most vulnerable areas

Weed infestation will be an ongoing problem if the weed is established on land adjacent to the forest. Weed species are prolific seed producers and can disperse seed over kilometres from a source. Wherever possible, neighbour co-operation in controlling weed species that threaten a forest should be sought and promoted.

A healthy forest with intact canopy and heavy indigenous regeneration (tree or shrub) around margins and in clearings is less susceptible to weed invasion than disturbed or modified forest (such as historically logged forest areas). Establishing indigenous seedlings on any open or disturbed areas as soon as possible (whether by facilitating natural regeneration or by planting) is a key component in reducing potential weed impacts.

Monitoring and control efforts should focus on the most vulnerable areas for weed establishment or spread. These are likely to be roads, landings, tracks and along forest margins, and harvest sites, particularly those close to seed sources. Vulnerable areas also include sites of natural disturbance such as slips, and places where seed may be carried and deposited in fertile, open areas such as stream banks and beds.

Practicing adaptive management

Successful weed management entails:

› implementation of control on priority species given information already available;
› periodic monitoring to see that any priority species under control decline in extent, or at least remain stable, and to note arrival of any new species;
› adoption of new control measures as new information comes available;

› and reporting of new weed species arrivals in an area (exchange of information provides access to existing knowledge, e.g. through NZERN, DOC and Regional Councils).

Decisions on when control might be required, and what control measures are necessary, are dependent on accurate, current information. To obtain accurate and current information on weed populations, their impacts on forest species (such as detrimental effects on regeneration, standing crop trees or other forest vegetation), the success of any control measures and physical impacts (such as access problems where gorse becomes well established) need to be described and monitored. Useful practices include taking notes and photographs, making maps of weed locations and recording control measures (what was done, when, and with what results).

Descriptions of the distribution and population size of weed infestations within the forest, prescriptions for inspecting and recording the spread of any weed or pest species, and follow-up control must be included in draft SFM Plans, SFM Permit applications and approved SFM Plans and Permits.

Standard 5.1.1.1 (see page 46) gives requirements for description of weed occurrence and prescribing weed control in SFM Plans and SFM Permits.

Harvest sites should usually regenerate, provided:
› large numbers of pests are not present;
› appropriate weed control is used where necessary;
› a seed source is present;
› ground cover on the site is not too dense (requiring control);
› the canopy species have produced viable seed crops.

Where there is a heavy cover of crown fern (*Blechnum discolor*) on the forest floor (a common feature on some beech forest sites), it may be necessary at a harvest site to create bare soil for germination of seedlings by grubbing some of the fern roots. A series of bare patches of soil about one metre square and about five metres apart across a felled gap should be sufficient to enable regeneration to establish at densities necessary to replace the stems removed in harvest.

A trial was conducted in an old-growth silver beech forest in Southland with between 10 and 30 percent basal area reduction (by selection harvest) of silver beech trees, log extraction by helicopter (minimal ground disturbance) and manual grubbing of crown fern (in areas two metres square). The results showed up to seven times the silver beech seedling density in grubbed zones compared with ungrubbed zones (TACCRA Ltd, 2006).

Where natural regeneration is patchy in beech forest, fern grubbing may be required over parts of a felling site. Coarse, woody debris, for example, stumps and parts of tree trunks left behind will also serve as elevated sites that may benefit regeneration where there is a heavy ground cover. Where coupes have been harvested using ground-based machines, scarification using a machine blade may be undertaken, but care should be exercised to maintain mineral soil cover.

Standard 5.1.1.2 (see page 46) requires harvest site inspection for weed presence and effect on forest regeneration.

PESTS, WILD ANIMALS, DOMESTIC STOCK, INSECTS

Regeneration of beech forest is not threatened by pests such as possums. However, possums often reach larger population numbers in, and have an impact on, broadleaved hardwood forest where both shrub and tree species are vulnerable to browse pressure. They may also have detrimental impacts on vulnerable species such as mistletoe, birds, fungi and invertebrates.

Goats probably pose the greatest threat to regenerating forest. They browse most plants and are attracted to open sites.

Pigs can have a significant impact on ground cover and regenerating forest if they are in moderate to high numbers. However pig-rooting can also provide sites for germination of shade-tolerant species.

Domestic stock can pose a threat to forest diversity and regeneration where the forest margin is accessible. The browsing and trampling impacts of cattle, for example, may extend 100 metres or more into the forest. Over long periods, forest margins do retreat where edge trees die and the ground cover becomes dominated by pasture species.

Mustelids are a direct threat to bats and birdlife, killing birds and destroying eggs in nests. Frugivorous birds (e.g. pigeons) are important seed dispersers for a variety of plant species, including miro and tawa and other podocarp species.

Wasps can build up to extremely high populations in late summer, particularly when the preceding winter has been mild. In high populations, wasps predate insect life and consume honeydew, reducing the food sources available for birds, both insectivorous and nectariferous.

The impacts of pests such as possums, rats, stoats and wasps on native wildlife, particularly bird populations, is difficult to assess.

Monitoring bird populations in some forests indicates that using poison bait stations can successfully control predators. However, success in controlling predators in managed forests is likely to be limited where reinvasion occurs from neighbouring forest.

Forest access (roads and tracks) may help spread predators and should be a focus of predator control. The spread of weeds and pests is most likely to happen along forest roads and possibly tracks and harvest sites, especially harvested coupes.

Forest owners should:

› ascertain whether their forests contain threatened bird or plant species;
› co-operate with neighbours in achieving effective pest control;
› seek advice on effective control methods.

It is strongly recommended that forest owners should:

› inspect (annually) all accessways where there is a risk of spread of weed species not naturally occurring in the forest;
› require that all machinery brought into the forest be cleaned prior to entering the forest (this should be a routine practice);
› carefully manage the use of chemical agents for pest and weed control so as to minimise impacts on indigenous species;
› monitor (annually) the effectiveness of control operations.

Handford (2000) describes methods for monitoring indicators of forest diversity and health, particularly in relation to weeds and pests and their impacts on flora and fauna.

Where inspection reveals the impacts of wild animals, pests or stock in a deterioration of forest canopy health, lack of forest regeneration or loss of biodiversity, remedial action will be necessary.

Standard 5.1.1.3 (see page 47) defines when animal/pest control be conducted.

Standard 5.1.1.4 (see page 47) sets fencing requirements to limit domestic stock damage to the forest.

SFM PLANS & PERMITS

GOAL 5.2: FOREST OPERATIONS ARE CONDUCTED SO AS TO MINIMISE RISK OF INCREASED INSECT PEST AND FUNGAL ATTACK

SFM PLANS & PERMITS

INDICATOR 5.2.1: SIGNS OF INSECT AND FUNGAL ATTACK

Natural mortality is an integral part of forest ecosystems. Silviculture, including harvesting, should be conducted with the goals of minimising operational damage to the forest and containing forest damage by insects and micro-organisms within naturally occurring levels (excluding epidemic events caused by drought, major storms or earthquakes).

The first signs of stress likely to be exhibited by trees suffering damage induced by harvesting are:

- holes and frass on tree trunks, indicating insect attack;
- yellowing of the crown;
- dieback of branches.

Such damage may be the result of branches damaged by the felling of adjacent trees, root damage caused by machines or interruption to drainage patterns.

In podocarp forest, damage suffered in natural events or as a result of forest management activity may not result in significant attack by insects. However, loss of bark, damage to root plates and broken branches may lead to stress, fungal decay and dieback of trees.

Rimu is particularly susceptible to root plate damage and the ponding caused by poorly constructed roads and use of heavy machines on poorly drained soils. If not corrected, such ponding will often lead to gradual dieback of affected trees.

Phytophthora taxon agathis (PTA) is a fungus-like organism causing kauri dieback in New Zealand kauri. This disease can kill seedlings and trees of all ages. In 2008, PTA was formally identified as a distinct and previously unknown species of *Phytophthora*.

The spores of PTA are found in the soil around infected kauri. Any movement of contaminated soil can spread the disease. Human activity resulting in the movement of soil attached to footwear, machinery or equipment is a significant vector for the disease. If operating in kauri forest special care should be taken to ensure machinery, footwear and equipment is clean when moving between properties and sites within properties. No harvesting should occur in areas known to be infected with PTA.

Hygiene procedures for working within kauri forests are available from regional authorities within the natural kauri range and on the Tiakina Kauri - Kauri Protection website: www.kauriprotection.co.nz These include hygiene procedures specifically targeted at machinery operators.

PTA is an unwanted organism under the Biosecurity Act 1993. As such hygiene procedures will be enforced by regulation under a regional plan if necessary.

Three species of wood-boring "pinhole" beetles (*Platypus apicalis*, *P. caviceps, P. gracilis*), breed in dead, moist wood in beech forest. They will also attack live trees that are under stress either from natural causes such as drought, or from the effects of forest operations – e.g. crown damage by felling, or root damage by machinery, log extraction or drainage impediment.

The fungus *Sporothrix* sp. and other fungi that the beetle introduce into the inner sapwood, and on which its larvae feed, are a greater threat to beech trees than the tunnelling of the adult beetle or the larvae. Attack by the fungus induces wilt symptoms; if an attack on a live tree is sufficiently concentrated, the affected part, or the whole tree, may die.

Where there is extensive damage induced in beech forest, for example as a result of natural events such as snow storms or earthquakes (resulting in a build up of dead wood), pinhole beetle populations may increase and pose a threat to healthy trees. Stands that have undergone silvicultural treatment such as thinning or harvesting may also contain large quantities of dead wood, providing ideal brood habitat.

Pinhole beetles do not usually attack trees less than 20 centimetres in diameter. The pinhole beetle larvae do not mature and emerge as adult beetles for two to four years, and where drying and decomposition of wood can be hastened (by cutting up large diameter (>20 centimetre diameter) stems into short sections, cutting flanges off stumps and cutting stumps as low as possible to ground level), this may limit successful brood development and emergence.

Research in north Westland beech forest indicates that cutting harvest residues to short lengths did not significantly reduce pinhole emergence (i.e. breeding), with large numbers of beetles still emerging from treated harvest residues five years later (Brockerhoff and Baker, 2003). There was no significant difference in levels of beetle emergence between drier and wetter harvest sites. The conclusion from information available to date is that cutting stem harvest residues to short lengths is unlikely to significantly reduce pinhole breeding at harvest sites of relatively small area (e.g. 0.04–0.2 hectares). The practice may possibly be beneficial in larger cleared areas with high exposure to sunlight and wind and where accelerated drying of cut material could occur

It appears to be of limited benefit to prescribe the strategy of cutting material into short lengths as a universal treatment at all beech forest harvest sites. Its effect as a forest hygiene treatment to limit pinhole beetle population buildup may be specific to individual forests and even individual harvest sites within forests. However, forest owners should consider it as a strategy where they believe it will be beneficial on a site by site basis (for harvest sites and thinnings sites).

Stump wood may be the most significant and long-term source of pinhole brood material at all harvest sites (Brockerhoff and Baker, 2003). If trimming flanges from stumps and felling as low as possible enables a higher proportion of wood that would otherwise remain on site (in the stump) to be extracted as log, then potential brood material volume is reduced. While such felling practice may not always increase stumpwood volume removed from the site (e.g. because a log found to be rotten or hollow after felling is trimmed before extraction), this may still be more beneficial in reducing pinhole breeding than if the material remained on the site as a stump.

Harvesting has the potential to increase the mortality of coupe edge trees (and other trees within a stand) from pinhole attack (Brockerhoff and Baker, 2003; Wardle, 1984), which can lead to dieback of coupe edges. As historical methods of treatment of harvest residues to control this have been shown to be of limited effect, all things considered, the most practical strategy for control of pinhole beetle in managed beech forests is likely to be a combination of appropriate silviculture and regular monitoring of forest condition about harvest sites (e.g. in the second or third year after harvesting).

SFM Plans should prescribe for post-harvest site monitoring in beech forests, along with followup provision for recovery of trees found to be affected by pinhole attack, wherever practicable, – providing the long-term risks to forest health from harvesting are not increased.

Strategies to minimise forest damage from silvicultural operations include:

› prescribing silvicultural systems suited to forest structure and type;
› selecting trees for harvest that can be felled without causing extensive damage to adjacent trees;
› adopting directional felling techniques to minimise damage to adjacent trees;
› felling trees damaged in the process of conducting silvicultural operations including harvesting, in lieu of other selected trees;
› selecting and operating harvest machinery suited to the conditions.

Field inspection and recording (photographs, descriptive records) of crown, trunk and root damage and condition of standing trees (whether damaged or not) adjacent to harvest sites, compared with other areas within the forest, provides a means of monitoring effects of silviculture and associated operations. Observed levels of pinhole beetle tunnels in stumps and other harvest residue and especially in standing trees, along with crown condition (wilting, yellowing, dieback), are key indicators in monitoring harvest sites in beech forest.

Standard 5.2.1.1 (see page 47) requires forest damage from insects or micro-organisms is not exacerbated by inappropriate silvicultural practices.

Standard 5.2.1.2 (see page 48) sets requirements for prescribing silviculture in SFM Plans and SFM Permits to limit forest damage.

Standard 5.2.1.3 (see page 48) gives requirements for prescribing forest protection measures in SFM Plans and SFM Permits in relation to harvesting and pinhole beetle.

Standard 5.2.1.4 (see page 49) sets prescriptions for inclusion in SFM Plans for monitoring pinhole beetle presence and reducing effects on the forest.

SFM PLANS & PERMITS

GOAL 5.3: FOREST OPERATIONS ARE CONDUCTED SO AS TO MINIMISE THE RISK OF FOREST FIRE

SFM PLANS & PERMITS

INDICATOR 5.3.1: PRESENCE OF FIRE SAFETY RULES AND EQUIPMENT

All draft SFM Plans and SFM Permit applications should include an evaluation of the risks to the forest from fire, and specify measures to protect the forest from fire. This will vary according to geographical location, forest type, management systems and machinery used, and the land cover and activities on neighbouring properties.

Protection measures should include:

› basic fire-fighting equipment (e.g. small portable fire extinguishers) carried by forest workers and contractors using chainsaws or other mechanised equipment;
› all machines and vehicles used in the forest carrying fire extinguishers;
› vehicles and machines being well maintained and fitted with spark arrestors as appropriate;
› where seasonal fire danger is high, landowners considering establishment of fire ponds/water points within the forest or adjacent to forest boundaries;
› forest workers operating in remote conditions in conjunction with helicopters being equipped with radiotelephone equipment.

Landowners should also maintain contact with, and seek advice from, Fire and Emergency New Zealand.

Standard 5.3.1.1 (see page 50) requires inclusion of fire protection measures in SFM Plans and SFM Permits.

CRITERION 6

MAINTAIN THE FULL RANGE OF AMENITIES

SFM PLANS & PERMITS

GOAL 6.1: CULTURAL AND HISTORIC SITES ARE IDENTIFIED AND, WHERE VULNERABLE, PROTECTED

SFM PLANS & PERMITS

INDICATOR 6.1.1: SPECIFIC SITES AND VALUES

Heritage New Zealand maintains a list of historic places, wāhi tapu and wāhi tapu areas. The list is known as the New Zealand Heritage List - Rārangi Kōrero (formerly 'the historic places register').

Historic places are divided into two categories:

› Category 1 historic places are places of special or outstanding historical or cultural significance or value;
› Category 2 historic places are places of cultural or historical heritage significance or value.

Historic places can include archaeological sites, buildings, trees, cemeteries, gardens, shipwrecks and other objects or places.

Some known archaeological sites may not be on the list. They include shipwrecks and places associated with human activity that occurred before 1900, for example, pā, urupā (burial sites), old roads, tramways and mining sites.

District Councils are required to take listed places into account when reviewing the District Plan or granting a resource consent. All District Councils have a copy of the New Zealand Heritage List, which is also available on the Heritage New Zealand website.

Sites most likely to be located in forest areas on private land are archaeological sites, wāhi tapu (sites of spiritual value to Māori), and wāhi tapu areas (groups of wāhi tapu). Sites of special significance to Māori may not be publicly known, and may or may not already be registered with Heritage New Zealand.

Where historic places are known and registered, the landholder, in preparing plans for forest management, is required to contact Heritage New Zealand to discuss proposed work and ensure that the work will not adversely affect the registered historic place.

Heritage New Zealand permits change to the use and function of places, and often the work or modifications that are necessary for this can be done with minimum impact.

Archaeological sites are also protected under Subpart 2 of the Heritage New Zealand Act 2014, which makes it an offence to damage, modify or destroy a site without authority from Heritage New Zealand.

Where a landholder believes a site may have historical or archaeological significance, this should be confirmed by contacting Heritage New Zealand. An inspection of the site may be required to ascertain its significance and the need for any protection or modification to forest management activity on and around the site. In the case of wāhi tapu and wāhi tapu areas, owners should consult with the local iwi as to appropriate protection or management.

Where archaeological or other sites are likely to be present within a forest area, an inspection of the forest is desirable to identify, record and evaluate any such sites for permanent protection. This is of particular importance in areas with a long history of occupation.

Standard 6.1.1.1 (see page 51) requires SFM Plans and SFM Permits record cultural and historic sites and specify appropriate management or protection.

SFM PLANS & PERMITS

GOAL 6.2: AMENITY VALUES ARE MAINTAINED

SFM PLANS & PERMITS

INDICATOR 6.2.1: APPEARANCE OF THE MANAGED FOREST RELATIVE TO UNMANAGED FOREST

LANDSCAPE LEVEL AESTHETIC VALUES

Much of the indigenous forest on private land forms a backdrop to the rural environment. It is often contiguous with, and indistinguishable from, protected forest contained within the Conservation estate. While there may generally be little use of a private forest for public recreation, it may have high landscape or amenity value by virtue of its location in relation to public roads, walkways and high-use conservation areas.

The forest operations most likely to impact on broad landscape values are timber harvesting and roading. Generally, harvesting in forests managed by single-tree or small-group systems will not be discernible at the landscape level to casual observers. Similarly, carefully sited and constructed access roads through high forest should not generally be visible from most public vantage points. Where forests managed by coupe (small clear-cut) systems are close to public use areas, the visual impacts of harvesting may be visible to casual observers.

Forest close to public use areas and vantage points may be better managed through the harvest of small coupes (0.05–0.1 hectare) rather than larger (0.5 hectare) coupes. Such considerations should be identified by the owner during the planning process and may be addressed in conditions attached to the approval of Annual Logging Plans by MPI.

Monitoring measures for assessing landscape level aesthetic effects include observation from selected vantage/photo-points and photographic records (may be repeated for a period including prior to and after operations).

Standard 6.2.1.1 (see page 51) sets performance expectations in respect of managed forest appearance in the landscape.

Standard 6.2.1.2 (see page 52) identifies coupe size limitation as a means of reducing visual impact of harvesting.

PROXIMAL AND IN-FOREST AESTHETIC/RECREATIONAL VALUES

Some private forests may fulfil significant public recreation functions. They may, with the owner's permission, provide access to the conservation estate for trampers or be used for other recreational activities. For those forests that are subject to varying degrees of public use or border such areas, the visual perception of change within the forest may be as important as, or more important than, more passive observation by "passers-by".

Perceptions of change within the forest will be influenced first and foremost by the visual appearance of harvest sites and accessways. The fewer trees harvested at one site, the less intrusive harvest sites will be. In the case of single-tree, small-group harvesting systems, harvesting impacts in sensitive areas (forest either used by the public or in close proximity to high-use areas) will be minimised where:

› stumps are cut low;
› large crowns are trimmed to reduce visual impacts;
› damage to adjacent trees and shrub tiers is avoided;
› no rubbish is left behind on harvest sites;

› forest operations are timed so as to avoid any safety risk to the public and to minimise the impacts of noise in periods of high recreational use of adjacent areas.

Where harvesting has been conducted by helicopter, the ground cover will be largely undisturbed and harvest sites will not be obvious to observers except at very close range.

The greatest visual impacts are likely to be associated with coupe felling and ground-based timber extraction. Coupe felling, while an accepted method of harvesting and regenerating beech and other light-demanding species, creates a more striking visual impression, especially immediately post-harvest. Unless harvesting is conducted in dry conditions and on well-drained soils, timber removal can have greater impacts than the felling operation.

Where logs are removed to landings within the forest for sorting and transportation, impacts on amenity values can be minimised by giving careful consideration to the siting and establishment of landings.

Ultimately, forest managers must determine safe working dimensions for machinery and personnel; this will vary depending on the systems in use and the scale of operation. *The Approved Code of Practice for Safety and Health in Forest Operations* (MBIE, 2012) provides rules pertaining to specific operations and use of forest machinery. MPI must have regard to these rules when reviewing aspects of forest management performance.

Monitoring measures for assessing operational performance and effects include field inspection or measurement and records of landing areas, and accessways (and their location), damaged edge trees, incidence of hang-ups, stumps and residues.

Standard 6.2.1.3 (see page 52) lists felling actions to assist in maintaining amenity values under coupe harvesting.

Standard 6.2.1.4 (see page 53) lists extraction measures to apply in reducing adverse visual effects.

CRITERION 7

FORESTS ARE MONITORED AND RECORDS ARE MAINTAINED

Monitoring of the forest is a necessary part of sustainable management. Over time, trends may be identified in plant and animal indicator species that reflect positive or adverse impacts of management systems. Trends in plant and animal frequency, plant composition and forest structure may indicate the success or otherwise of pest control or the maintenance of specific habitat requirements. Regeneration, growth and mortality rates of tree species will provide the basis for reviewing management systems and sustainable harvest levels.

This is the basis for adaptive management – responding to identifiable changes and modifying management systems to maintain a healthy, functioning forest ecosystem. This requires an adequate information baseline, provided by initial forest description, inventory and establishment of permanent monitoring systems and record-keeping which, when remeasured over time, will provide a basis for assessing the performance of forest management and maintenance of natural processes.

SFM PLANS & PERMITS

GOAL 7.1: NATURAL VALUES ARE MONITORED ON A REGULAR BASIS

SFM PLANS & PERMITS

INDICATOR 7.1.1: INDICATOR SPECIES MEASUREMENT, FLORA AND FAUNA DESCRIPTION

Handford (2000) provides a number of methods for undertaking fauna assessment including the five-minute bird count, the most widely used method for assessing relative abundance of birds.

Large differences in results are likely if measurements are undertaken in different seasons, so successive counts should be undertaken at the same time of year. The forest reconnaissance description procedure detailed in Allen (1992) is one means of monitoring and describing flora and fauna; this method and its variants have seen widespread application in New Zealand forests. Handford (2000) provides alternative methods for monitoring flora.

Long-term monitoring is an integral component of forest management under SFM Plans and is compatible with their term of effect. Forest descriptions, including fauna observations/counts including those for any identified indicator species, should be reviewed at no more than ten-year intervals with more regular inspections carried out where specific values are identified (individual species or aggregates of species). Where specified in an SFM Permit, measures to be taken to protect the forest and to retain flora and fauna may incorporate monitoring provisions. Long-term monitoring for review of forest descriptions (extending beyond the ten-year term of any SFM Permit) is an activity a forest owner may elect to do, but it is not mandatory.

Standard 7.1.1.1 (see page 54) provides for review of forest descriptions and sets maximum periodicity of this.

SFM PLANS & PERMITS

INDICATOR 7.1.2: FOREST COMPOSITION AND STRUCTURE (INCLUDING HABITAT TREES)

Forest inspection and where necessary supplementary forest description and inventory needs to be undertaken periodically to confirm that species composition and structure are being maintained. Inventory and forest description methods have been described previously. Periodic forest inspections and inventory need to be conducted according to the same methods to enable valid results comparison.

Standard 7.1.2.1 (see page 55) requires periodic monitoring of forest composition and structure.

SFM PLANS & PERMITS

INDICATOR 7.1.3: FOREST MARGINS, WETLANDS AND CLEARINGS

Forest margins, wetlands and natural clearings need to be inspected, with records of condition and change updated regularly. Probably the best means of drawing comparisons is to use fixed photo-points and compare photographs over a time period. Unless there is significant natural or induced disturbance to the forest, any background change is likely to be difficult to ascertain except where the forest is undergoing successional change.

Standard 7.1.3.1 (see page 55) requires periodic monitoring of natural values.

SFM PLANS

GOAL 7.2: AMENITY VALUES ARE MONITORED ON A REGULAR BASIS

SFM PLANS

INDICATOR 7.2.1: FOREST APPEARANCE AT THE LANDSCAPE LEVEL, PLEASANTNESS, AESTHETIC COHERENCE AND CULTURAL AND RECREATIONAL ATTRIBUTES

Fixed photo-points will provide the best medium-term measure of any management-induced change to forest appearance at the landscape level.

Standard 7.2.1.1 (see page 56) prescribes monitoring and records update to check for any change in amenity values.

SFM PLANS

GOAL 7.3: FOREST GROWTH, RECRUITMENT AND MORTALITY IS MONITORED

SFM PLANS

INDICATOR 7.3.1: RESULTS FROM MONITORING HARVEST SITES AND PERMANENT SAMPLE PLOTS

For most forests, rates of harvest and management prescriptions are approved on the basis of the best available information. This may include reasonably comprehensive data from nearby forests subject to scientific or management research, or may be data that have regional, rather than local significance. In any event the underlying assumptions about growth, recruitment and mortality, on which approved rates of harvest are based, need to be confirmed over time through periodic monitoring of sample plots established for the purpose. These provide the data, together with assessment of the results/impacts of silvicultural management operations (including harvesting), to compare with original assumptions, for review of SFM Plans as necessary, and for amendment or endorsement of management prescriptions and approved rates of harvest. For larger forest areas one plot per 50 hectares is probably sufficient, with a minimum of five plots per forest type.

The number of PSPs to be established and their location will be agreed between MPI and the owner and specified in the registered SFM Plan.

Ideally, PSPs should be established when forest inventory is undertaken. The type and size of PSPs vary. What suits one forest type may not suit another. As for initial inventory, infrequently occurring species may not be adequately sampled in a few sample plots and additional effort may be necessary to build up a useful long-term picture of trends in growth, etc.

For beech forest, permanent plots of 0.04 hectares are satisfactory and a methodology for their establishment is described by Allen (1993). However, this system was developed for ecological study, and a few modifications are desirable for monitoring in a production forest environment. For example, individual stem height measurement is desirable, and possibly quality class assessment. This plot size may also be suited to broadleaved hardwood forest (e.g. tawa-dominant forest) where stem densities are high.

For mixed forest (e.g. podocarp–broadleaved hardwood forest) with low stem densities, larger plots are desirable. Plots of 0.1 hectare, and in some circumstances even larger, are more likely to incorporate enough stems to provide good long-term data. Even then some species may not be well represented in PSPs and may require other forms of monitoring to obtain information on replacement, growth and mortality.

A simple plot layout that suits the needs of long term monitoring is the circular plot layout. This is most efficiently established by tagging and measuring trees over the entire plot, tagging and measuring poles over a smaller sub-plot, and counting seedlings and saplings on a yet smaller sub-plot or number of sub-plots within the larger plot.

The forest reconnaissance (Allen, 1992) is probably the most widespread method of recording forest composition and structure in New Zealand. It is recommended that this method be employed by landowners, both in conjunction with initial inventories and the re-measurement of permanent sample plots. Other temporary methods of recording forest attributes to monitor forest change are described in Handford (2000).

MPI will inspect records and locations of PSPs and over time compare the owner's records of recruitment, growth and mortality to the data used to establish approved harvest rates. These data will also be reviewed in relation to management performance: that is, actual harvests, post-harvest impacts, etc.

Standard 7.3.1.1 (see page 56) requires SFM Plans contain prescriptions for forest monitoring using PSPs.

Standard 7.3.1.2 (see page 56) requires PSP establishment and sets the maximum time for this to be completed.

SFM PLANS

GOAL 7.4: FOREST REGENERATION IS MONITORED ON A REGULAR BASIS

SFM PLANS & PERMITS

INDICATOR 7.4.1: RECORDS OF LOCATION AND STATUS OF REGENERATION ON HARVESTED SITES

KAURI, PODOCARPS AND SHADE-TOLERANT OR EXPOSURE-SENSITIVE BROADLEAVED HARDWOODS

These species groups are required to be managed under single-tree small-group selection systems. The trigger for supplementary planting is the presence or absence of sufficient advanced growth (refer Goal 2.2). Such regeneration assessment assumes a different significance for these species groups than for beech and other light-demanding species, and so no standard is included in this sub-section. Where it has been determined that no supplementary planting is required, it is still advantageous to revisit harvest sites, record post-harvest damage and remedial action required, and assess the status of natural regeneration.

In gaps created by the felling of single trees or small groups, a count of all seedlings present can often be undertaken in a short time. Where there is a failure of regeneration in harvest gaps, consideration should be given to planting replacement seedling stocks. Such decisions will be influenced by forest type and the species under consideration. There may be justification to review planting decisions on the basis of forest management performance, on an annual or periodic basis.

BEECH AND OTHER LIGHT-DEMANDING HARDWOODS

In beech forests, harvested coupes should be inspected and sample plots measured one year after harvesting and thereafter on a five-yearly basis, until it is clear that the regeneration attained on the site is sufficient to restock the coupe and has survived beyond the initial establishment stage. The assessment of the frequency of seedlings in a number of small, randomly located plots should be sufficient to indicate effective regeneration density.

For example, the presence of at least one seedling in 50 percent of, say, 50 plots of one square metre systematically located in a 0.1 hectare coupe indicates a relative stocking of about 5000 stems per hectare. An initial effective stocking of about 500 stems per hectare, well distributed across a coupe is about the minimum recommended to re-establish the forest structure. Typically, beech forests will exhibit up to about 30 000 seedlings per hectare following a full mast year on a good site free from competing vegetation.

The Global Positioning System (GPS) is a useful tool for maintaining records of harvest sites and for relocating sites for follow-up inspection.

Standard 7.4.1.1 (see page 57) sets time limits for inspecting harvest site regeneration and gives details of records required.

SFM PLANS & PERMITS

GOAL 7.5: SILVICULTURAL OPERATIONS ARE RECORDED

SFM PLANS & PERMITS

INDICATOR 7.5.1: SUPPLEMENTARY PLANTING

The success of supplementary planting undertaken in response to lack of sufficient advanced growth or to remedy a failure in seedling establishment and survival at harvest sites is likely to be a critical factor in maintaining species composition of the forest. The requirement for planting (number of sites and their distribution) can also be an indicator of the state of natural regeneration within forest types and throughout the forest area, a key consideration in determining silviculture and making adjustments to existing regimes. Assessment of the success of planting (seedling survival), and whether further planting is required, depends on monitoring the planted stock. Successful monitoring depends on accurate records of location, species and numbers of seedlings planted.

Planting sites should be inspected one year and five years after planting, and survival of seedlings recorded. Thereafter, planting sites need to be inspected periodically. Assessment at five-yearly intervals is desirable because there may be times when further supplementary planting is required.

As a component of Annual Logging Plan approval (subsequent to the first), MPI may request records of planting undertaken, and may conduct a field inspection prior to Annual Logging Plan approval or as a post-harvest assessment, to check planting location and planting rate.

Standard 7.5.1.1 (see page 57) prescribes the type of records to be kept on supplementary planting.

Standard 7.5.1.2 (see page 58) sets timing for inspection of planting sites, and requires records of seedling survival.

SFM PLANS & PERMITS

INDICATOR 7.5.2: FOREST HEALTH

Where forest damage or mortality is observed as a result of harvesting activity, management systems, including harvesting methods, should be reviewed and improved to minimise impacts on stand health. Periodic observation should be made to assess change in general forest health, as indicated by insect and fungal attack, canopy colour and density change (where yellowing and thinning may indicate health decline) and rates of tree mortality, especially of trees adjacent to harvest sites or accessways. Photo-points and aerial photography can aid in monitoring and provide a record of change.

Standard 7.5.2.1 (see page 58) sets timing, attributes for assessment and recording needs in monitoring forest health.

SFM PLANS

INDICATOR 7.5.3: FOREST TENDING

Where beech forest management incorporates silvicultural tending (thinning, pruning) to maintain stem growth and form records of operations are an essential component of management. Minimum silvicultural records include harvest site/coupe number and location, estimated regeneration density before thinning, density (or spacing) after thinning, pruning height and predominant mean height (average height of the 100 tallest individuals per hectare).

Standard 7.5.3.1 (see page 58) prescribes type of silvicultural records required of forest tending.

SFM PLANS & PERMITS

INDICATOR 7.5.4: HARVEST REGULATION AND RECORDS

The regulation of the quantity of timber harvested annually or periodically is an important part of sustainable forest management. There are likely to be two types of records kept by a landowner – timber harvest records (standing volume) and recovered (sold) log volumes.

Timber harvest records need to be maintained, by species, location and species' volumes, for each year harvesting is undertaken, with the volume of standing trees selected and marked for harvest being determined at the time of selection for harvest.

Standing volume is the basis for harvest regulation. It is determined from measurements and methods consistent with those used in the forest inventory, forest appraisal or in obtaining estimates of the forest resource on which the approved allowable harvest is based. Generally, the harvest volume (standing volume) and volume sold will not be the same.

The volume of standing trees selected and marked for harvest is determined from:

› the measurement of diameter at breast height (1.4 metres above ground level) with deduction as appropriate for visible abnormality (excessive butt swell, fluting/flanging) that renders any section of a tree bole (or toplog) unmillable;
› the height of the main stem of the tree to a predetermined top diameter (usually 15 centimetres, or the point at which the main stem branches into the crown);
› estimates of centre girth diameter and length of any toplogs.

These measurements are to be taken at the time of selection for harvest and, along with the volume determined from them, be recorded on a species by species basis. This information may be requested by MPI as a "felling list" prior to approval of an Annual Logging Plan.

Totalled progressively as the selection process is undertaken, these records of volume selected indicate when the permissible standing harvest volume, by species, has been reached.

Where weight scale is used to measure and control harvest (smallwood products), weights must be converted to equivalent standing volume measure for recording and reporting.

Standard 7.5.4.1 (see page 59) sets the minimum harvest recording requirements.

Standard 7.5.4.2 (see page 59) prescribes the measurements for standing volume determination of trees comprising any harvest.

Standard 7.5.4.3 (see page 60) requires consistency between measurements used in harvest regulation, defining allowable harvest and initial resource quantification.

SFM PLANS & PERMITS

INDICATOR 7.5.5: RECOVERED TIMBER VOLUMES

While the harvest is regulated by standing tree volume measured, landowners must also maintain records of the volumes of logs, by species, loaded onto trucks and despatched to sawmills or other processing facilities.

The unit of measure in this case is likely to be either a weighbridge record or cylindrical log measure, calculated from cylinder volume tables or functions (NZ Forest Service, 1970). These units of measure are not comparable to the standing measure. Also there may be a significant part of the measured tree trunk left in the forest as non-merchantable material. This volume is of particular interest to the owner, as it influences the profitability of a forest management operation. This statistic, while not essential, is also of interest to MPI, since it forms part of the approved harvest of standing volume. Recovered log volumes are sourced at regular intervals from registered sawmillers, who must maintain and provide periodic returns, by landowner and location, to MPI.

STAND RECORD – EXAMPLE

DATE:	COMPT. NO. COUPE NO.	HARVEST TOTAL VOLUME	REGENERATION DENSITY	PLANTING PRUNING THINNING	NOTES: FOREST HEALTH WEEDS, ANIMALS
20/7/00	Compt.5/3	red beech 70m³ harvested (45.4m³ sawlog delivered) silver beech 120m³ harvested (72.3m³ sawlog delivered)	13 000 sph silver beech 2000 sph red beech MTH* 1.0 m		Edge trees – nil damage
5/03/10			MTH 3.0.m	Waste thinned to 2000 sph	
15/4/21			MTH 5.5 m	Waste thinned to 750 sph	

*mean tree height

This form of stand recording is suitable for management of even-aged patches of forest. Where the forest is managed on a single-tree or small-group basis, records may need to be more extensive but harvest volumes, regeneration estimates, observations of residual damage and planting records should be maintained, if not on a site basis, on a compartment basis.

Standard 7.5.5.1 (see page 60) defines obligatory harvest and timber destination records.

CRITERION 8

COMPLY WITH OTHER RELEVANT LEGISLATION

SFM PLANS & PERMITS

GOAL 8.1: ENSURE APPLICATION OF THE FORESTS ACT IS COMPATIBLE WITH THE OBLIGATIONS OF LANDOWNERS UNDER OTHER LEGISLATION

SFM PLANS & PERMITS

INDICATOR 8.1.1: NON-COMPLIANCE OF ACTIVITIES (WHETHER PROPOSED OR CONDUCTED) UNDER THE FORESTS ACT WITH OTHER LEGISLATION OR CODES OF PRACTICE

There are many statutes aside from the Forests Act that may impact on forest managers. *The NZIF Handbook* provides a list of directly and indirectly applicable statutes.

Three statutes that require a good understanding and are likely to impose important obligations on owners and managers of indigenous forest are the:

› Resource Management Act 1991 (particularly with respect to soil and water protection);
› Health and Safety at Work Act 2015 (safety and health of persons);
› Fire and Emergency Act 2017 (fire protection).

Review of SFM Plans, SFM Permits and Annual Logging Plans and receipt of advice from landowners and/or statutory authorities are strategies MPI can use, as required, to verify legislative compliance. This may result in MPI requiring changes to SFM Plans, SFM Permits and Annual Logging Plans, and in setting any conditions in Annual Logging Plans.

Standard 8.1.1.1 (see page 61) requires complete legal compliance by all forest activities proposed in or conducted under any SFM Plan, SFM Permit or Annual Logging Plan.

RESOURCE MANAGEMENT ACT 1991

This legislation and its representation through Policy Statements and Regional and District Plans promotes the sustainable management of natural and physical resources by managing their use, development and protection. To this end Regional Councils may control the use of land for soil and water conservation, and District Councils may control any actual or potential effects of the use, development or protection of land.

SFM Plans are required to specify the relevant requirements of all applicable District and Regional Plans. This would include provisions and rules attached to felling indigenous vegetation; operating in areas zoned as significant natural areas (if part or all of the forest falls into such a zone); undertaking earthworks, and ensuring protection of rivers, streams and other water bodies and their associated riparian margins.

It should be noted that Section 17 of the RMA gives every person a duty to avoid, remedy or mitigate adverse effects on the environment. This applies even when District and Regional Plans are silent.

Standard 8.1.1.2 (see page 61) lists information an SFM Plan must provide in respect of Regional and District Plan content.

Before any activity is initiated on land subject to a registered SFM Plan or SFM Permit, any resource consent required by the relevant Regional or District Council must be obtained.

Regional and District Plans may determine rules for the restoration, enhancement or protection of natural and physical resources, including protection of soils and the maintenance of water quality. It is likely, too, that prescriptions in SFM Plans will either directly or indirectly address these issues (e.g. in relation to Representative Areas, soil protection, maintenance of water quality and management/protection of riparian areas). Prescriptions in SFM Plans may vary from rules in Regional and District Plans only where such variation results in more stringent performance requirements.

While the Forests Act requires that SFM Plans specify the relevant details of all applicable District and Regional Plans under the Resource Management Act 1991, such specification is not mandatory for SFM Permits. This does not mean, however, that activities conducted under SFM Permits are exempt from any requirements of District or Regional Plans.

The Forests Act does require SFM Permit applications (and approved SFM Permits) to specify protection measures to retain and enhance flora, fauna, and soil and water quality of the forest area. These measures must at least be consistent with requirements of the relevant District and Regional Plans.

As for SFM Plans, prescriptions in SFM Permits may vary from rules in Regional and District Plans only where such variation results in more stringent performance requirements.

Standard 8.1.1.3 (see page 62) requires consistency between SFM Plan and SFM Permit prescriptions and requirements of Regional and District Plans.

HEALTH AND SAFETY AT WORK ACT 2015

The Ministry of Business, Innovation and Employment (MBIE), in consultation with the forestry industry, developed *An Approved Code of Practice for Safety and Health in Forest Operations*, published in 2012. It is a statement of statutory requirements, rules and provisions, based on preferred work practices and arrangements, for the purpose of ensuring the safety and health of persons to which the code applies.

As defined by the code, a forest operation "includes activities associated with land preparation, establishment, silviculture, harvesting and transportation."

The code places duties on employers, self-employed people and employees, and advises how to comply with the Health and Safety in Employment Act 1992 (Since replaced by the Health and Safety at Work Act 2015).

If a potential conflict is identified between the code and any prescription in a draft SFM Plan, SFM Permit application or Annual Logging Plan submitted for approval, appropriate amendment is required to either remove the source of the potential conflict or ensure safe work practices take precedence.

An example where health and safety considerations take precedence over silvicultural prescription could be the felling of single trees and small groups of trees in dense stands where there may be potential for hang-ups, or where other hazards may be identified in satisfying specific silvicultural prescriptions e.g.

helicopter harvesting. Where such hazards exist, safe work practices should take precedence over silvicultural prescriptions. However, a record should be kept of instances where approved silvicultural practices have been set aside in the interests of safety and health.

Standard 8.1.1.4 (see page 62) assigns precedence to health and safety over silvicultural and operational practice and requires amendment to silviculture or work practice to achieve this.

FIRE AND EMERGENCY ACT 2017

This legislation provides for the protection of areas from fires, including vegetation fires.

Protection of the indigenous forest from fire is one of the important elements of protection required in SFM Plans and SFM Permits under Clause 8 of the Second Schedule to the Forests Act. The more general fire precautions are described in Goal 5.3. In areas prone to high fire risk additional measures may be advisable. Landowners should consult with should consult with Fire and Emergency New Zealand and obtain advice on contingency planning where appropriate.

The Fire and Emergency Act 2017 and associated regulations and management code of practice shall take precedence in any situation where there is a conflict between fire protection required by the above legislation and prescribed practices in approved SFM Plans or approved Annual Logging Plans.

MPI review of draft SFM Plans, SFM Permit applications and Annual Logging Plans submitted for approval may involve liaising with, and obtaining confirmation from, Fire and Emergency

New Zealand in respect of legislative requirements. If a potential conflict is identified between any prescription in any of these documents, and the provisions of the The Fire and Emergency Act 2017, its associated regulations and Management Code of Practice, the prescription will be appropriately amended.

Standard 8.1.1.5 (see page 63) assigns precedence to legislative requirements for fire protection over provisions of SFM Plans, SFM Permits and Annual Logging Plans and requires amendment to these to remove any inconsistencies.

APPENDICES

APPENDIX A

INDIGENOUS TREE SPECIES REFERRED TO IN THE STANDARDS AND GUIDELINES

(as defined by group in the Forests Act)

KAURI AND PODOCARPS

Kauri	*Agathis australis*
Rimu	*Dacrydium cupressinum*
Kahikatea	*Dacrycarpus dacrydioides*
Matai	*Prumnopitys taxifolia*
Miro	*Prumnopitys ferruginea*
Totara	*Podocarpus totara*
Hall's totara	*Podocarpus hallii*
Silver pine	*Manoao colensoi*
Kaikawaka	*Libocedrus bidwillii*

BROADLEAVED HARDWOODS

(other than beech and including light-demanding hardwoods, e.g. manuka and kanuka)

Tawa	*Beilschmiedia tawa*
Taraire	*Beilschmiedia tarairi*
Hinau	*Elaeocarpus dentatus*
Pokaka	*Elaeocarpus hookerianus*
Pukatea	*Laurelia novae-zelandiae*
Northern rata	*Metrosideros robusta*
Southern rata	*Metrosideros umbellata*
Rewarewa	*Knightia excelsa*
Kamahi	*Weinmannia racemosa*
Towai	*Weinmannia silvicola*

Quintinia	*Quintinia acutifolia*
Puriri	*Vitex lucens*
Maire	*Nestegis* spp.
Mangeao	*Litsea calicaris*
Kanuka	*Kunzea ericoides*
Manuka	*Leptospermum scoparium*

BEECHES

Red beech	*Fuscospora fusca (Nothofagus fusca)*
Silver beech	*Lophozonia menziesii (Nothofagus menziesii)*
Hard beech	*Fuscospora truncata (Nothofagus truncata)*
Black beech	*Fuscospora solandri (Nothofagus solandri)*
Mountain beech	*Fuscospora cliffortioides*

APPENDIX B

INDIGENOUS AVIFAUNA REFERRED TO IN THE STANDARDS AND GUIDELINES

Kaka	*Nestor meridionalis meridionalis*
Kakariki	*Cyanoramphus* spp.
Rifleman	*Acanthisitta chloris*
Yellowhead	*Mohoua ochrocephala*
Keruru (pigeon)	*Hemiphaga novaeseelandiae novaeseelandiae*
Kiwi	*Apteryx* spp.

APPENDIX C
TABLES LINKING MPI STANDARDS TO KEY PROVISIONS IN THE FORESTS ACT 1949

GENERAL NOTES

1. Clause numbers refer to clauses in the Second Schedule to the Forests Act 1949, while other numbers refer to provisions in the Forests Act, mainly in Part 3A.
2. These tables refer to provisions that are immediately relevant to particular elements of the standard. In a situation where someone queries the application of the element to their particular circumstances, other provisions of the Forests Act may be relevant.
3. Sections 67F(3), 67H(1) and 67J(1) apply to all notes on SFM Plans. Section 67M(7) applies to all notes on SFM Permits. Reference to Clause 9 brings Section 67H(2) into play.

CRITERION 1

STANDARD ELEMENT	SFM PLANS	SFM PERMITS
Standard 1.1.1.1		Standard 1.1.1.1
1	S2 "landholding" and "owner", 67F(1), Clauses 1, 7, 8 and 10.	1 S2 "landholding" and "owner", 67M(1), Clauses 8 and 10
2	Clause 3	2 67M(1)
3	Clause 2	3 67M(2)(b)
4	Clause 4	4 67M(1) and (2)(a)
5	Clause 5	5 67M(1) and (2)(a)
6	Clause 6	6 Clause 8(a)
7	67H(1)(c), Clauses 7 and 8	7 Clause 8(b)
8	Clause 8(a)	
9	Clause 8(b)	

CRITERION 2

STANDARD ELEMENT	SFM PLANS	SFM PERMITS
Standard 2.1.1.1	67N and Clause 10(2)(a), Clause 8(b)	67N and Clause 10(2)(a), Clause 8(b)
Standard 2.1.2.1	67N, Clauses 8, 9 and 10(2)(a), 67H(2)(c)	67N, Clauses 8, 9 and 10(2)(a), 67H(2)(c)
Standard 2.1.2.2	67N, Clauses 8, 9 and 10(2)(a), 67H(2)(c)	67N, Clauses 8, 9 and 10(2)(a), 67H(2)(c)
Standard 2.1.3.1	Clauses 7, 8, 10(1), (2)(b), (c) and (d)	Clauses 8, 10(1), (2)(b), (c) and (d)
Standard 2.1.4.1	Clauses 7, 8(a) and (b), 10, 67O (for beech), 67H(1)(e) and 67H(2)(b)	Clauses 8(a) and (b), 10, 67O (for beech), 67H(2)(b)
Standard 2.2.1.1	Clause 10(2)(b)	Clause 10(2)(b)
Standard 2.2.1.2	Clause 10(2)(b)	Clause 10(2)(b)
Standard 2.2.1.3	67H(2)(b), 67T(e), Clauses 8, 9(2)(e), 9(3)(b) and (c), and 10(2)(b)	67H(2)(b), 67T(e), Clauses 8, 9(2)(e), 9(3)(b) and (c), and 10(2)(b)
Standard 2.2.1.4	67V, Clauses 4, 8, 9(3)(b) and (c), and 10(2)(b)	67V, Clauses 8, 9(3)(b) and (c), and 10(2)(b)
Standard 2.2.1.5	67H(2)(c), Clauses 9(2) and 10(1) and (2)(b)	67H(2)(c), Clauses 9(2) and 10(1) and (2)(b)
Standard 2.2.1.6	Clauses 8(b), 9(2), 10(1) and (2)(b), 67H(2)(c)	Clauses 8(b), 9(2), 10(1) and (2)(b), 67H(2)(c)
Standard 2.2.1.7	Clause 10(2)(d)	Clause 10(2)(d)
Standard 2.2.1.8	Clause 10(2)(d)	Clause 10(2)(d)
Standard 2.2.1.9	67H(2)(b), 67T(e), Clauses 8, 9(3)(b), (c), and (e), 10(2)(d)	67H(2)(b), 67T(e), Clauses 8, 9(3)(b), (c), and (e), 10(2)(d)
Standard 2.2.1.10	Clause 10(2)(d)	Clause 10(2)(d)
Standard 2.2.1.11	Clause 10(2)(c)	Clause 10(2)(c)
Standard 2.2.1.12	67O(2) to (4)	67O(2) to (4)
Standard 2.2.1.13	Clause 10(3)	Clause 10(3)
Standard 2.2.2.1	Clause 10(2)(e)	Clause 10(2)(e)
Standard 2.2.2.2	Clause 10(2)(e)	Clause 10(2)(e)
Standard 2.2.3.1	Clauses 8(a) and 10(2)(f)	Clauses 8(a) and 10(2)(f)
Standard 2.2.3.2	Clauses 7 and 10(2)(f)	Clause 10(2)(f), although there are no specific requirements on planting density
Standard 2.2.3.3	Clause 10(2)(f)	Clause 10(2)(f)
Standard 2.3.1.1	67N(b), Clauses 8 and 10(2)	67N(b), Clauses 8 and 10(2)
Standard 2.3.1.2	67T(d) and Clause 10(2)(a)	67T(d) and Clause 10(2)(a)
Standard 2.3.1.3	67H(1)(a), Clauses 1 and 10(2)(a)	67M(2)(b) and Clause 10(2)(a)
Standard 2.4.1.1	Clauses 7 and 8	Clause 8
Standard 2.4.1.2	Clauses 7 and 8	Clause 8
Standard 2.4.1.3	67F(2) and (3), 67H(1)(f), Clauses 7 and 8	67F(2), Clause 8
Standard 2.4.2.1	67B, 67H(1)(f), Clauses 7 and 8	
Standard 2.4.3.1	Clauses 7 and 8	

CRITERION 3

STANDARD ELEMENT	SFM PLANS	SFM PERMITS
Standard 3.1.1.1	Clauses 2(a) and 6	67M, 67H(2)(c) and Clause 9(1)
Standard 3.1.1.2	67H(1)(c), and Clauses 1, 2, 6, 7 and 8, 67F(3)	Clause 8
Standard 3.1.1.3	Clauses 6(c), 7, and 8	Clause 8
Standard 3.1.1.4	67H(1)(c), and Clauses 6(c), 7 and 8	Clause 8
Standard 3.1.1.5	Clauses 6, 7 and 8	Clause 8
Standard 3.1.1.6	Clauses 6, 7 and 8	Clause 8
Standard 3.1.1.7	67N, Clauses 6, 7 and 8	Clause 8
Standard 3.1.1.8	67H(1)(c), and Clause 6	MPI Responsibility where required re Section 67(M)(3) & (4)
Standard 3.1.2.1	Clause 6(c)	MPI Responsibility where required re Section 67(M)(3) & (4)
Standard 3.1.2.2	67H(1)(b), Clauses 6(c) and 10(1)	MPI Responsibility where required re Section 67(M)(3) & (4)
Standard 3.1.3.1	67H(1)(b), Clauses 6(c) and 10(1)	
Standard 3.1.3.2	67H(1)(b), Clauses 6(c) and 10(1)	
Standard 3.2.1.1	67H(1)(b), Clauses 6, 7, and 10(1)	67M(3) and (4), Clause 10(1)
Standard 3.2.1.2	67H(1)(b) and (d), 67H(2)(b) and (c), Clauses 7, 8, and 10(1) and (2)	
Standard 3.2.1.3	67H(1)(c), 67T(d), Clause 7	67T(d), Clause 9(3)
Standard 3.2.2.1	S2 "timber", 67D(1)(a) On "natural values" – Clauses 7, 8, 9, 10(1)	S2 "timber", 67D(1)(a), On "natural values"– Clauses 8, 9, 10(1)
Standard 3.3.1.1	67H(1A) and (2)(b), Clause 9	67H(1A) and (2)(b), Clause 9
Standard 3.3.1.2	67H(2)(b), Clause 9(2)	67M(2)(a) and (b), and Clause 9(2)
Standard 3.3.1.3	Clause 9(2)	Clause 9(2)
Standard 3.3.1.4	67T(d) or (f)	67T(d) or (f)
Standard 3.4.1.1	67I(1)(b), (2) and (5)	67I(1)(b), (2) and (5)
Standard 3.4.2.1	67I(1)(b), (2) and (5)	
Standard 3.4.2.2	67H(1)(c), 67I(1)(b), (2) and (5), 67R, Clauses 7, 8 (Re penalty provisions) 67T	(Re penalty provisions) 67T
Standard 3.4.3.1	67I(2) and (5)	
Standard 3.4.3.2	67I1(b) and (2)	
Standard 3.4.3.3	67I(1), (2) and (5); S 13 Interpretation Act 1999 may also be relevant where "over-cutting" is caused by an error or omission; e.g. wrong information when applying for approval	

CRITERION 4

STANDARD ELEMENT	SFM PLANS	SFM PERMITS
Standard 4.1.1.1	Clauses 4, 7, 8(b) and 9	Clause 8(b) and 9
Standard 4.1.1.2	67V, Clauses 4, 7, 8(b) and 9(3)	67V and Clauses 8(b), 9(3)
Standard 4.1.1.3	67V, and Clauses 4, 7, 8(b), and 9(3)	67V and Clauses 8(b), 9(3)
Standard 4.2.1.1	67T(d), 67V, Clause 4	67T(d), 67V
Standard 4.2.1.2	67V, Clauses 4, 7 and 8	67V, Clause 8
Standard 4.2.1.3	67V, Clauses 4, 8 and 9	67V, Clauses 8 and 9
Standard 4.3.1.1	Clauses 8 and 9	Clauses 8 and 9

CRITERION 5

STANDARD ELEMENT	SFM PLANS	SFM PERMITS
Standard 5.1.1.1	67B, 67H(1)(c) and Clause 8	Clause 8
Standard 5.1.1.2	67B, 67H(1)(c) and Clause 8	67B and Clause 8
Standard 5.1.1.3	67B and Clause 8	67B and Clause 8
Standard 5.1.1.4	67B and Clause 8	67B and Clause 8
Standard 5.2.1.1	Clauses 7 and 8	Clause 8
Standard 5.2.1.2	67H(2)(c), Clauses 7, 8, 9(2), 9(3)(b) and (d)	67H(2)(c), Clauses 8, 9(2), 9(3)(b) and (d)
Standard 5.2.1.3	67B, Clauses 7 and 8	67B and Clause 8
Standard 5.2.1.4	67B, Clauses 7 and 8	
Standard 5.3.1.1	Clause 8(a)	Clause 8(a)

CRITERION 6

STANDARD ELEMENT	SFM PLANS	SFM PERMITS
Standard 6.1.1.1	67B, 67H(1), 67I(1)(b)(i), 67V, Clauses 4, 7 and 9(3)	67B, 67I(1)(b)(i), 67V, Clause 9(3)
Standard 6.2.1.1	67B, 67H(1), 67I(1)(b)(i), 67V, Clauses 4, 7 and 9(3)	67B, 67I(1)(b)(i), 67V, Clause 9(3)
Standard 6.2.1.2	67B, Clauses 7, 9 and 10(2)(c)	67B, Clauses 9 and 10(2)(c)
Standard 6.2.1.3	67B, Clauses 7, 8, 9 and 10(2)(c)	67B, Clauses 8, 9 and 10(2)(c)
Standard 6.2.1.4	67B, Clause 9(3)(b) and (c)	67B, Clause 9(3)(b) and (c)

CRITERION 7

STANDARD ELEMENT	SFM PLANS	SFM PERMITS
Standard 7.1.1.1	Owner inspection – 67H(1)(c) and (f), 67F(3), Clauses 7, 8(b) and 10(2)(b). MPI inspection – 67I(2) and (5), 67R, 71B	Owner inspection – Clauses 8(b) and 10(2)(b). MPI inspection – 67I(2) and (5), 67R, 71B
Standard 7.1.2.1	Owner inspection – 67H(1)(c) and (f), 67F(3), Clauses 7 and 10(2)(B). MPI inspection – 67I(2) and (5), 67R, 71B	Owner inspection – Clause 10(2)(b). MPI inspection - 67I(2) and (5), 67R , 71B
Standard 7.1.3.1	Owner inspection – 67H(1)(c) and (f), 67F(3), Clauses 7 and 8(b). MPI inspection – 67I(2) and (5), 67R, 71B	Owner inspection – 67M(7), Clause 8(b). MPI inspection – 67I(2) and (5), 67R , 71B
Standard 7.2.1.1	Owner inspection – 67H(1)(c) and (f), 67F(3), clauses 7 and 10(2)(b). MPI inspection – 67I(2) and (5), 67R , 71B "Amenity values" 2	
Standard 7.3.1.1	67B, 67H(1)(c), 67I(1)(b)(i), (2), and (5), Clauses 7 and 8	
Standard 7.3.1.2	67B, 67H(1)(c), 67I(1)(b)(i), (2), and (5), Clauses 7 and 8	
Standard 7.4.1.1	67H(1)(c), 67I(2) and (5), 67T(d), Clauses 7, 8, 9(3)(a), and 10(1), (2)(e) and (f)	67I(2) and (5), 67T(d), Clauses 8, 9(3)(a) and 10(1), (2)(e) and (f)
Standard 7.5.1.1	67H(1)(c), 67I(2) and (5), 67T(d), Clauses 7, 8, and 10(2)(e) and (f)	67I(2) and (5), 67T(d), Clauses 8, 10(2)(e) and (f)
Standard 7.5.1.2	67H(1)(c), 67I(2) and (5), 67T(d), Clauses 7, 8, and 10(1), (2)(e) and (f)	67I(2) and (5), 67T(d), Clauses 8, 10(1), (2)(e) and (f)
Standard 7.5.2.1	67H(1)(c), Clauses 7, 8, 10(2)(e) and (f)	Clauses 8, 10(2)(e) and (f)
Standard 7.5.3.1	67H(1)(c), Clauses 7, 8, 10(2)(e) and (f)	
Standard 7.5.4.1	67H(1)(c), Clauses 7, 8, 10(1), (2)(e) and (f)	Clauses 8, 10(1), (2)(e) and (f)
Standard 7.5.4.2	67H(1)(c), 67H(2)(c), 67T(d), Clauses 6(a), 7, 9(2) and 9(3)	67H(2)(c), 67T(d), Clauses 9(2) and 9(3)
Standard 7.5.4.3	67H(1)(c), Clauses 7, 8, and 9	Clause 8(b) and 10(1)
Standard 7.5.5.1	67H(1)(c), 67Q(2) (but not at present for actual form of record), 67T(d), Clauses 7 and 10(1)	67T(d), 67Q(2) (but not at present for actual form of record), Clause 10(1)

CRITERION 8

STANDARD ELEMENT	SFM PLANS	SFM PERMITS
Standard 8.1.1.1	Where possible should interpret Forests Act provisions in a manner consistent with all the other legislation, but see below.	Where possible should interpret Forests Act provisions in a manner consistent with all the other legislation, but see below.
Standard 8.1.1.2	67V and Clause 4	
Standard 8.1.1.3	67V, Clauses 4, 7, and 8	67V, Clause 8 Where possible should interpret Forests Act provisions in a manner consistent with all the other legislation.
Standard 8.1.1.4	+ Where possible should interpret Forests Act provisions in a manner consistent with all the other legislation. While it seems logical that HSE and Rural Fires regimes take precedence over SFM plans and permits, it is by no means black-and-white. There is a need to consider each situation on its particular facts.	See +
Standard 8.1.1.5	See +	See +

APPENDIX D
GLOSSARY OF TERMS

The definitions give meaning to terms applied to SFM pursuant to the Forests Act. Words enclosed in quotation marks are taken from the Forests Act or are terms used in the body of these standards and defined in this glossary.

Accuracy	How close a sample estimate of a population (e.g. sample estimate of "stand" volume) is to the true population value. The true value is not usually known; sample accuracy is normally judged from sample "precision".
Adaptive management	A systematic process for continually improving management policies and practices by learning from the outcomes of operational programmes.
Advanced growth	Young trees that have become established naturally before any harvesting of older trees is undertaken. For the purpose of this standard, advanced growth is defined as "seedlings", "saplings" and "poles".
Adventive weeds	Undesirable plants, both herbaceous and woody, that appear outside their usual habitat.
Allowable harvest	The quantity of timber that may be harvested annually, usually expressed as species per unit area (e.g. "m3/ha of red beech") or as a total annual quantity for the forest area as a whole. In the case of an SFM Permit, the allowable harvest is the volume

of timber (by species) available for harvest over the term of the permit.

Amenity values/Amenities "Those natural or physical qualities and characteristics of an area that contribute to people's appreciation of its pleasantness, aesthetic coherence, and cultural and recreational attributes."

Anthropogenic Caused by human activity (e.g. modification of a forest by harvesting or burning trees).

Appraisal (of forest) An informed judgement of forest type status and condition by way of an estimate of standing volume, size-class distribution and regeneration by species, and a description of forest type attributes including flora and fauna, soil and water, and amenity values.

Basal area The area of the cross section of the stem of a tree at breast height (1.4 metres above ground level) including bark. Basal area is often used to provide a measure of site occupancy of a species or group of species, expressed as "m^2/ha".

Bole A stem with one or more leaders.

Bias A systematic error (of measurement) that affects all measurements the same way. A sample mean may be precise but biased; that is, the sample measurements are clustered closely about their mean but do not represent the true value.

Biodiversity
The numbers and distribution of all flora and fauna from time to time existing on the land.

Broadleaved
Used in the Forests Act in the terms "shade-tolerant and/or exposure-sensitive broadleaved hardwood species". A term applied to angiosperms: trees and shrubs that reproduce by producing seeds in an ovary and having leaves of relatively large area. Distinguished in the Forests Act from (small-leaved) "light-demanding hardwoods" (also angiosperms) such as beech.

Centre girth diameter
Centre girth diameter means the diameter (outside bark) of a log at a point equidistant from each end, where diameter is determined from measured circumference using the formula circumference/π = diameter. In the case of toplogs in standing trees where circumference cannot be measured manually, centre girth diameter is determined by visual estimate or by use of an appropriate measuring device (e.g. Spiegel relaskop).

Canopy gap
A space on the forest floor created by the felling, death or toppling of a tree or trees. The area is defined by the vertical projection to the ground of the edges of the crowns of standing trees surrounding the canopy gap. Canopy gap area may diminish rapidly as the crowns of edge trees grow to occupy the gap, referred to as "gap infilling". For this reason, "expanded gap" area is a more repeatable measure over time.

Composition The variety of species present within an area of forest.

Confidence limits The statistical way of indicating the reliability of an estimate calculated from (preferably) a random sample. Usually expressed as a value above and below the sample mean within which the true mean will lie, at a specified probability level for sampling. For example, the volume of rimu in a forest may be estimated, on the basis of a sample measurement of trees, to be 100 cubic metres per hectare ("m^3/ha") ± 10 m^3/ha at 95 percent probability level of sampling. The 95 percent lower and upper confidence limits are thus 90 m^3/ha and 110 m^3/ha and this range is the 95 percent "confidence interval". This means that the mean stand volume is between 90 m^3/ha and 110 m^3/ha unless a one in twenty chance has occurred in sampling the forest. The wider the confidence limits, the less reliable the estimate is deemed to be.

Coupe An area of clear-cut (felled) forest where all trees are felled in the designated area.

Crown Point of a tree at which, owing to heavy branching, no further utilisation is considered possible i.e., beyond which there is no timber (excepting any toplogs) capable of being milled.

Density The number of stems per unit area, usually expressed as stems per hectare (sph).

Diameter at breast height (dbh)	The forestry standard height at which diameter of standing trees is measured for inventory purposes (e.g. calculation of standing volume, basal area, determination of size class for individual stems). In New Zealand this is 1.4 m above ground level. For trees on sloping ground, dbh is measured from ground level on the uphill side of the stem.
Directional felling	Felling a tree in a pre-determined direction, usually with the aim of minimising damage to adjacent trees or advanced growth.
Disturbance history	Past events, both natural and anthropogenic, that have influenced the "composition" and "structure" of a forest.
Domestic stock	Referred in the Forests Act as "stock". Taken to include, but not confined to, sheep, cattle, pigs, goats, deer and horses.
Estimate	Usually derived from a measured sample (forest "inventory"). Used to quantify a characteristic of a population (e.g. stand volume). In respect of SFM Permits "estimate" also includes predictions based on documented information pertaining to a similar forest or group of forests, or from a subjective assessment based on the knowledge and experience of the assessor, or both. In the latter two circumstances the estimate will therefore not be accompanied by confidence intervals and its reliability cannot be expressed in statistical terms.

Expanded gap	The area calculated from measurement between the trunks of trees nearest to and surrounding the "canopy gap".
Exposure-sensitive	Tree species that are susceptible to damage to their foliage resulting from increased exposure to wind or frost (e.g. tawa on some sites).
Felling cycle	The interval between successive harvests in a forest area.
Forest area	The area within which harvesting will be undertaken, defined on a map attached to a registered SFM Plan or Permit.
Forest type	A class of forest vegetation that is sufficiently distinct to require different management from other forest types.
Frass	The excrement of insects. In the case of wood-boring insects, frass is otherwise known as borer dust.
Growth rate	The annual or periodic increase in the dimensions of a forest variable or parameter (e.g. diameter and height or basal area and volume, respectively).
Harvest(ing)	The process of felling and transporting logs within the forest area.
Harvest rate	The annual or periodic allowable harvest. May be expressed as m^3/ha/annum, or m^3/annum, or m^3/period for the "forest area". Defined in a registered

	SFM Plan as the annual allowable harvest from the "forest area". Defined in a registered SFM Permit as the volume of timber available for harvest over the term of the permit.
Harvest regulation	The technical and administrative aspects of controlling the quantity of timber harvested from the forest so that the "allowable harvest" is not exceeded.
Indicator	A quantitative or qualitative variable that can be measured or described which, when observed periodically, demonstrates trends (e.g. the change in distribution or density of a plant or animal species).
Indigenous	A species of flora or fauna that occurs naturally in New Zealand or arrived in New Zealand without human assistance.
Indigenous forest land	"Land wholly or predominantly under the cover of indigenous flora."
Industrial wood	Applied to wood that is not of "sawlog" quality. Usually refers to wood suitable for production of pulp or other reconstituted wood products.
Ingrowth	Stems attaining a predetermined size during a measurement period (e.g. poles growing into the tree size class (diameter of 30 cm or more) between two measurements).

Inventory	A survey of a forest area to provide information on forest species including, but not limited to, information on the quantity of timber of commercial tree species present and their growth rates.
Landholding	"An estate, right, title, or interest of any kind in or over an area of land by or under which indigenous timber may be harvested; but does not include an interest by way of charge or security."
Light-demanding	Refers to tree species requiring relatively high levels of light for seedling survival, growth and recruitment into the forest canopy e.g. some beech species and "seral" species such as manuka and kanuka.
Low-impact techniques	The management of forests in such a way that the impacts on the forest from conducting "silvicultural" operations are minimal (e.g. the use of low ground-pressure tractors to minimise soil compaction).
Merchantable	That quantity of a tree assessed to contain timber "capable of being volume milled".
Micro-organism	Includes algae, bacteria, fungi and viruses.
Milled (capable of being)	Timber having been subjected to an operation or process involving a sawmill. Capable of being milled (millable) means timber of sufficient dimension (including defect) to enable production of sawn timber.

Modified forest Forest that as a result of previous harvesting or other human interference displays characteristics that differ from unmodified forest of the same type.

Natural values The attributes of the individual and interrelated biological and physical components, and processes of an area (this is further discussed under Criterion 2).

Near-natural Forest management under silvicultural systems that aim to approximate the natural dynamics of similar stands not under management, while economically and safely maintaining (or where appropriate improving) stand and ecosystem health and quality; and where the impacts of forest management are within the range of naturally occurring changes in the forest.

Owner (landowner) "Any person who owns a 'landholding' and includes the owners of any landholding where it is owned by two or more persons and a group of owners of landholdings who are operating under the same Sustainable Management Plan."

Periodic harvest The maximum "allowable harvest" permitted for a given period, expressed either on a per hectare basis or for the forest area as a whole (e.g. m^3/ten year period).

Periodic mean annual increment The average annual increase or decline in, for example, merchantable stand volume (m^3/ha) over a measurement period, including, in uneven-aged forest, average annual ingrowth, mortality, harvests and survivor growth over the measurement period.

Permanent sample plot (PSP)	A permanently marked area within which the tree species and other forest variables are marked and measured at periodic intervals to provide estimates of forest growth and other forest change.
Pest	While not defined in the Forests Act, pests are taken to include wild animals (pursuant to the Wild Animal Control Act 1977) including feral deer, possums, goats and pigs, where they are in sufficient numbers to seriously impact on natural values and forest regeneration. Other significant pests include the mustelids (ferrets, stoats and weasels), rats and insects such as wasps.
Podocarp	Conifers (cone-bearers) belonging to the Podocarpaceae family, often referred to as softwood tree species. Of these, rimu is the most important timber-producing podocarp and is one of the most widespread tree species in New Zealand .
Pole	Refer "size class", and "advanced growth".
Precision	The degree of agreement of a series of measurements. Usually expressed as the standard error of the mean (a statistical term) or as confidence intervals, sample precision describes the size of the deviation of the of sample values about their own mean.
Predators	Pest species that predate (kill and feed on) fauna including native birds and invertebrate species. Includes possums, mustelids, rats and wasps.

Probable limits of error (PLE)	Confidence limit expressed as a percentage of the sample "estimate", i.e. mean. A term only used in New Zealand.
Recruitment	Trees that enter a particular size class or classes in a given time period (e.g. poles growing into the 30–39 centimetre tree size class in a given time or "recruitment" period.
Representative species	Synonymous with "indicator" species.
Riparian	In relation to vegetation, growing in close proximity to a watercourse, lake, swamp or spring, and often dependent on its roots reaching the water table.
Sample	A part of a population consisting of one or more sampling units selected and measured as representative of the whole.
Sapling	Refer "size class" and "advanced growth".
Scarification	Disturbing the forest floor and exposing bare mineral soil to provide suitable conditions for the germination of natural seedfall.
Seedling	Refer "size class" and "advanced growth".
Senesce(nt)	Trees that are becoming old and have passed the period of maximum growth.

Seral Part of a sequence of vegetation succession. Usually applied to forest species that colonise disturbed sites (e.g. resulting from natural events causing canopy gaps, or forest harvesting, fire, etc) and are succeeded by other, usually taller species that germinate and grow under the shelter of the seral species (e.g. manuka and kanuka).

Shade-tolerant Tree species that display the ability to regenerate and grow in shaded conditions (e.g. tawa is one of New Zealand's most shade-tolerant tree species).

Silviculture (silvicultural) The management of trees to provide timber (includes planting, pruning, thinning, and harvesting).

Size class Usually diameter classes used to describe stand structure and the merchantable element of the forest (e.g. seedling – 30 centimetres to 1.4 metres high; sapling – 1.4 metres high to 9.9 centimetres dbh; pole – 10 to 19.9 centimetres dbh; small tree – 20 to 29.9 centimetres dbh; tree – 30 to 39.9 centimetres dbh, 40 to 49.9 centimetres dbh etc.). N.B. Above "tree" size class categories are examples commonly used for forest descriptive purposes – for legal definition refer "Trees".

Smallwood A term applied to roundwood too small to be milled and often utilised for posts, poles or firewood.

Stand A community, particularly of trees, displaying sufficient uniformity as regards composition, spatial distribution and structure as to be distinguishable from adjacent communities (e.g. a forest area may consist of a number of differently aged stands of trees). Often loosely applied to the trees within a forest type.

Stand composition (forest composition) The variety of tree species present in a stand (or within a given forest type).

Standing volume The volume of the bole of a tree, obtained before the tree is felled, by the measurement of "dbh" and height to the point where the bole branches into the crown of the tree, or to a minimum diameter of 15 centimetres (whichever occurs first), with deductions only for visible abnormality or defect that renders any section of the bole not capable of being milled, and includes large branches (toplogs) contained within the crown of the tree that have a minimum small end diameter of 15 centimetres, a 20 centimetres centre girth diameter and a minimum length of 2.5 metres and are capable of being milled. Diameter (at a point where centre girth would be measured) and length dimensions of any toplogs in standing trees may be estimated. The volume of any tree that has been felled or has fallen naturally is measured in the same fashion. These measurements are usually used in conjunction with either a volume table or volume equation to determine standing volume (generally inside bark).

Stand structure (forest structure)	The manner in which the tree species are arranged within a stand (or forest type) on a three-dimensional basis (e.g. the presence and numbers of tree species in a range of height tiers (classes)). The "reconnaissance" forest description methodology provides for the recording of all plant species along with an indication of their relative abundance within predetermined height tiers (refer Criterion 3 Standard 3.1.1.2).
Supplementary planting /restocking	Planting of seedlings in the event that advanced growth (of kauri, podocarp and shade-tolerant or exposure-sensitive broadleaved hardwood species) is judged to be insufficient, or where there is a failure of regeneration in beech or light-demanding hardwood forest.
Timber	"Trees (excluding cuttings, suckers and shoots), woody plants able to be milled, and includes branches, roots, and stumps of trees and other woody plants able to be milled, logs, woodchips, wood products, veneer, tree ferns and tree fern fibre."
Trees	"Not only timber trees but also all kinds of other trees, shrubs, and bushes, seedlings, cuttings, suckers and shoots of every description."
Toplog	A length of stem or branch capable of being milled and occurring as one or more large branches from the bole section and/or in the crown of a tree – i.e. not contained within the bole. Minimum toplog

dimensions are taken to be 15 centimetres small end diameter with 20 centimetres centre girth diameter, and 2.5 metres long.

Units of measure

mm – millimetre(s)
cm – centimetre(s)
m – metre(s)
ha – hectare(s)
dbh – diameter at breast height (1.4 m above ground level)
m^2/ha – square metres per hectare
m^3/ha – cubic metres per hectare
sph – stems per hectare

Volume

The volume of a tree or log, expressed as cubic metres.

Volume control

Controlling the harvest from a forest by monitoring the standing volume of timber selected and harvested.

Volume equation (and volume tables)

A mathematically derived relationship permitting the calculation (or reading from a table) of the volume of the bole (usually inside-bark) from the measurement of variables such as dbh and height.

Weed

Undesirable vegetation, often comprising herbaceous plants, shrubs and ferns that have the potential to suppress forest regeneration.

Wild animal

Refer “pest.”

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