Criteria and Indicators in the Eden RFA region

A report undertaken for the NSW CRA/RFA Steering Committee
April 1998

CRITERIA AND INDICATORS IN THE EDEN RFA REGION

CHAPTER 1 WAS DEVELOPED BY THE ESFM GROUP
APPENDIX 2-12 HAVE BEEN PREPARED BY FORTECH AND CSIRO FOR NPWS ON BEHALF OF THE ESFM GROUP

A report undertaken for the NSW CRA/RFA Steering Committee project number NE 26/ESFM

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Report Status

This report has been prepared as a working paper for the NSW CRA/RFA Steering Committee under the direction of the ESFM Group. It is recognised that it may contain errors that require correction but it is released to be consistent with the principle that information related to the comprehensive regional assessment process in New South Wales will be made publicly available.

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This project has been jointly funded by the New South Wales and Commonwealth Governments. The work undertaken within this project has been managed by the joint NSW / Commonwealth CRA/RFA Steering Committee which includes representatives from the NSW and Commonwealth Governments and stakeholder groups.

The project has been overseen and the methodology has been developed through the ESFM Group which includes representatives from the NSW and Commonwealth Governments and stakeholder groups.

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1. EXECUTIVE SUMMARY

Project objectives

The main objectives of the project were:

- to produce criteria, indicators and targets for the Eden Region which could be used to measure the ecologically sustainable forest management of forests both quantitatively and qualitatively;
- to recommend the appropriate mechanisms for measuring, monitoring and reporting on each indicator; and
- to recommend specific target levels for each of the criteria and indicators.

Methods

The project comprised the following major components:

- Workshops of local stakeholders and experts via the Eden Regional Forest Forum to inform the community of current thinking with regard to indicators, and to guide discussion to obtain meaningful input on indicators relevant for Eden. Membership of the Eden Regional Forest Forum comprised the relevant stakeholders required for the discussion.
- Preparation of an expert report which drew together resource material on current international and national trends and the state of information on the use of criteria and indicators. This is presented in Appendix 2-12.
- The ESFM Group used input from the Regional Forest Forum and the expert report to develop a draft set of indicators in 3 categories according to ease of implementation, to meet the requirements of ecologically sustainable forest management. This is presented in Chapter 1.

Key results and products

Criteria and indicators provide a mechanism with which to assess changes in the extent or number of identified forest values. Taken together, the indicators help assess the sustainability of forest management. Targets are set to measure indicators against and monitoring systems are used to generate the necessary data for this. Criteria, indicators, targets and monitoring systems are therefore part of a dynamic process aimed at improving the sustainability of forest management.

The following criteria are used to assess ecological sustainable forest management in the Eden region: biodiversity, productive capacity of forests, ecosystem health, soil and water quality, social and economic values and natural and cultural heritage values. A series of 22 indicators were developed for the above criteria. For example, *the extent of forest/vegetation type by growth stage* is one indicator developed to monitor biodiversity. Specific targets and monitoring systems for each indicator are being developed by the Ecologically Sustainable Forest Management Technical Committee.

A TYPE INDICATORS

1. BIO-DIVERSITY

Indicator 1.1:

Extent of forest/vegetation type by growth stage.

Indicator 1.2:

Extent of connectivity in the forest landscape in relation to:

i) threatened species habitat;

ii) general retained habitat on public and private land;

iii) conservation reserves.

Indicator 1.3

Interim for firest five years of the RFA

Management measures in place to maintain species extent and abundance.

PRODUCTIVE CAPACITY

Indicator 2.1a

Annual removal of timber products and non timber products from forest ecosystems.

Indicator 2.3

Standing volume of log stocks by species association and diameter class for multi-aged native forest land available for timber production by land tenure.

SOIL AND WATER

Indicator 4.1

Road category density and stream crossing density by catchment for the total RFA area including forest and non forest.

ECONOMIC AND SOCIAL

Indicator 5.1

Mean volume and royalty value of logs harvested per annum by species and grade by tenure.

Indicator 5.4

Employment numbers by type across all forest users in Eden region.

CULTURAL AND HERITAGE

Indicator 6.1

Change in condition and number of recorded places, artefacts, sites, buildings or other structures.

B and C TYPE INDICATORS

BIO-DIVERSITY

Indicator 1.3b (B Type)

List of representative species by extent and abundance. Representative sample to include threatened species, key functional groups and indicator species.

PRODUCTIVE CAPACITY

Indicator 2.1b (B Type)

Annual removal of timber and non timber products from forest ecosystems compared with that estimated to be ecologically sustainable by tenure.

Indicator 2.2 (C type):

Site quality and conservation of nutrients in forest ecosystems.

HEALTH AND VITALITY

Indicator 3.1 (B Type)

Lists of biological factors influencing forest health and vitality including (weeds, feral animals, insects and diseases).

Indicator 3.2 (B Type)

Impact of fire on forest related values.

SOIL AND WATER

Indicator 4.2 (B Type)

Changes to macro-invertibrate diversity in streams.

Indicator 4.3 (C type)

Extent and proportion of physical disturbance from harvesting and fire.

Indicator 4.4 (B Type)

Proportion of catchment likely to be harvested from 1997-2019 by harvest system as an immediate proxy determination of possible influence on water quality.

Indicator 4.5 (B Type)

Assess the change in the level of growth stages from 1997-2019 by catchment as an immediate proxy rating of water quantity.

ECONOMIC AND SOCIAL

Indicator 5.2 (B type):

Total volume, value of products and production, and flow-on economic contribution compared to cost of production for all products.

Indicator 5.3 (B type):

Availability and uses of recreational/tourism facilities.

Indicator 5.5 (B type):

Gross income index.

CULTURAL AND HERITAGE

Indicator 6.2 (C type):

Level of participation in decision making process post RFA encompassing indigenous and non indigenous issues related to forest management.

1. ESFM PERFORMANCE INDICATORS

1.1 INTRODUCTION

The ESFM principles (Appendix 1) have led to the identification of twenty indicators that will be the foundation used for future evaluation of performance in ESFM in the Eden Region. Some of these indicators will be monitored commencing immediately upon signing of the RFA, others will be subject to further research and development activities during the life of the RFA. The monitoring of the indicators is specified carefully and will be implemented as a cooperative activity by land managers.

Performance review against the indicators will occur on a 5-yearly basis, and will be jointly undertaken by the State and Commonwealth government. Changes to the indicators or the monitoring systems will also be jointly agreed by the two governments. The management response to the results of the 5-yearly review of RFA performance in implementing ESFM will be based on consultation with stakeholders and endorsed by the two governments.

The implementation of ESFM will also be guided by regulatory and socio-economic commitments, including protocols for the conservation of biodiversity, protection of soil and water, protection of cultural heritage values, commitments to industry, provision of access and recreational facilities to the public and the protection of the forest and public property from threats due to wildfire and exotic pests or weeds. These practices and commitments should also be considered a key part of the RFA and their successful implementation should be monitored alongside the performance indicators.

Implementation of ESFM in the Eden RFA must be viewed as a challenge of continuous improvement by management agencies, Indigenous people, stakeholders, industry, workers and the general public. The two governments have committed to undertake implementation activities related to the RFA that will support enhanced data collection, worker skills development, improved recognition of Indigenous economic, social, cultural and environmental values, ecological field guides, research and development and management of private lands. Successful implementation will also rely on effective mechanisms to facilitate ongoing input from stakeholders and clear accountability by management agencies for undtaking agreed actions. These commitments and approaches to implementing ESFM in the Eden RFA are detailed in the following sections of this attachment.

Indicators are designed to provide information in an understandable way. We have long used indicators for assessing economic performance such as Gross National Product or Per Capita income. Most people have also come to recognize Social Indicators like employment rates, life expectancy and birth rates. In ESFM, however, the use of indicators is an attempt to reflect the key environmental, social and economic aspects of a healthy regional society. This means that a 'basket' of indicators has been chosen that will help portray the quality of life related to the Forests of Eden. These indicators are meant to assess our performance in implementing the Eden RFA and to help assess over time whether we are achieving what we set out to do.

The indicators are not perfect, but they are meant to be a practical attempt to identify performance measures across the range of themes that have been raised by the community and by specialists. The indicators will require a commitment to data collection by management agencies, communities and forest-dependant businesses. Successful implementation will also require a collective commitment by stakeholders and forest conservation and management agencies to monitor and interpret the trends in the indicators over time.

It is not possible to define in concrete terms what levels of these indicators are necessary or appropriate. It is more likely that changes will occur in every aspect of our economy, communities and our environment over time. These changes may occur from natural processes of growth or wildfire, or from changes in markets for forest products. The RFA period of 20 years means that there will be a need to cope with these changes and adjust course in our management as necessary. The indicators can be a tool to help make those course adjustments when necessary.

Interpretation of the indicators will need to be undertaken carefully, as many factors can contribute to the overall performance of forest management.

Three categories of performance indicators are developed for the RFA:

A type: data substantially available to quantify current situation and can be used to review performance after five years.

B type: data not currently available, but can be implemented durng the first five years of theRFA agreement and used to review performance after five years.

C type: are recommended for design of a monitoring process during the RFA period.

Where applicable, the indicators have current available data which reflect the present state of the indicator.

The following indicators are designed to reflect community values related to biodiversity, forest productivity, soil and water conservation, socio-economic benefits and cultural heritage. Each indicator has associated with it a target or targets that can be assessed over time. These indicators are based on data currently available or readily available and will be used for the monitoring and evaluation of the RFA in the first five year period.

1.2 BIODIVERSITY

Biodiversity is the variability among living organisms and the ecological complexes of which they are a part. This includes diversity within species, among species, and of ecosystems. The protection of biodiversity enables the ecosystem to respond to external influences, to recover after disturbance, and to maintain the organisms essential for its ecological processes. Human activities should conserve ecosystems by retaining habitats, and controlling deleterious species. A reduction in the diversity of species in a region may reduce the ability of the ecosystems to function, reduce their productivity, and so reduce sustainability. Therefore, all naturally occuring species should be maintained in the ecosystem.

There is a need to enhance the level of scientific understanding, and to develop methods to direct science and policy to the achievement of sustainability. There are many approaches and methods to enhance and maintain biodiversity, both through a comprehensive, adequate and representative protected areas system and through conservation protocols and planning on State Forests and private lands. The following indicators should provide insiqht over time of the effectiveness of those mechanisms in conserving biodiversity in the forests of the Eden RFA region.

Two forms of this indicator are presented: one based on Keith/ Bedward/Smith vegetation types (Table 1), and the other on State Forests ecosystem types (Table 2). The indicator has a different application depending on the focus of implementation: for State Forests, the focus is identification of field types; for NPWS, the focus is on correlation with JANIS types for conservation values.

The data in these tables is sourced from the Environment and Heritage Technical Committee produced layer of vegetation community model and the FRAMES Technical Committee produced layer of growth stages. The data represents pre RFA assessment and provides the current situation. All rainforest types are recorded within a rainforest growth stage and are not further delineated into a growth stage structure for this exercise. The sections of the table that are shaded indicate forest types that are non-commercial.

1.2.1 Indicator 1.1

- Extent of forest/vegetation type by growth stage (Table 1.1 and 1.2).

TABLE 1.1
INDICATOR 1.1- PART A (BASED ON KBS VEGETATION TYPES):

vegetation type name	size	current (1997) growth stage

		candidate old growth	disturbed old growth	mature forest	disturbed mature forest	young forest	recently disturbed
dry rainforest							
myanba eucalypt/fig forest							
rocky top dry shrub forest							
a silve/p brogo shrub rainforest							
bunga head rainforest							
coastal warm temperate rainforest							
hinterland warm temperate rainforest							
cool temperate rainforest							
mountain wet layered	percentage	25%	13%	28%	9%	18%	8%
forest *(E.nitens)*	area (ha)	437	221	493	158	314	137
mountain wet layered	percentage	25%	3%	29%	10%	16%	16%
forest *(E.fastigata)*	area (ha)	4115	481	4817	1700	2671	2704
tantawangalo wet shrub	percentage	26%	14%	27%	14%	10%	8%
forest	area (ha)	201	110	210	105	76	63
mountain wet fern forest	percentage	28%	3%	44%	4%	8%	13%
	area (ha)	607	76	960	86	179	296
hinterland wet fern forest	percentage	23%	1%	44%	4%	22%	6%
	area (ha)	9447	549	17855	1529	8860	2383
hinterland wet shrub forest	percentage	17%	1%	40%	4%	31%	7%
	area (ha)	4017	258	9720	923	7466	1672
mountain wet herb forest	percentage	20%	3%	33%	10%	14%	20%
	area (ha)	5757	915	9726	2798	4030	5882
basalt wet herb forest	percentage	15%	3%	28%	12%	22%	19%
	area (ha)	1659	382	3112	1332	2396	2051
flats wet herb forest	percentage	11%	1%	47%	18%	17%	8%
	area (ha)	271	15	1167	439	416	192
brogo wet vine forest	percentage	12%	2%	47%	4%	35%	0%
	area (ha)	390	75	1534	119	1139	1
bega wet shrub forest	percentage	26%	2%	36%	5%	28%	3%

	area (ha)	2855	194	3936	527	2977	330
bega dry grass forest	percentage	17%	1%	52%	2%	27%	1%
	area (ha)	284	21	879	32	457	18
candelo dry grass forest	percentage	38%	0%	38%	12%	12%	1%
	area (ha)	319	2	321	98	99	6
monaro dry grass forest	percentage	24%	0%	67%	0%	9%	0%
	area (ha)	757	0	2084	3	276	0
numeralla dry shrub	percentage	34%	1%	36%	5%	21%	2%
woodland	area (ha)	2314	78	2483	366	1414	164
monaro grassland	percentage	67%	11%	19%	0%	2%	0%
	area (ha)	56	9	16	0	2	0
monaro basalt grass	percentage	33%	1%	29%	9%	24%	3%
woodland	area (ha)	435	17	387	117	321	35
subalpine dry shrub forest	percentage	38%	3%	32%	6%	15%	6%
	area (ha)	7930	534	6559	1344	3119	1263
sandstone dry shrub forest	percentage	24%	0%	61%	0%	7%	8%
	area (ha)	187	0	484	0	54	64
tableland dry shrub forest	percentage	11%	1%	39%	2%	27%	20%
	area (ha)	1501	144	5551	248	3836	2866
waalimma dry grass forest	percentage	6%	3%	27%	1%	45%	19%
	area (ha)	76	35	356	8	584	253
wog wog dry grass forest	percentage	13%	0%	16%	0%	62%	9%
	area (ha)	118	0	150	0	568	83
nalbaugh dry grass forest	percentage	11%	1%	32%	12%	16%	28%
	area (ha)	198	25	568	221	281	506
wallagaraugh dry grass	percentage	10%	1%	54%	1%	21%	13%
forest	area (ha)	81	5	439	11	174	110
hinterland dry grass forest	percentage	20%	4%	38%	5%	20%	13%
	area (ha)	5268	999	9934	1386	5171	3349
coastal dry shrub forest	percentage	10%	2%	35%	14%	31%	7%
(E.longifolia)	area (ha)	2290	509	7563	3004	6883	1631
coastal dry shrub forest	percentage	18%	1%	52%	1%	17%	11%
(E.muellerana)	area (ha)	2804	113	8131	185	2622	1724

brogo dry shrub forest	percentage	26%	6%	29%	13%	22%	5%
	area (ha)	3213	728	3544	1580	2741	627
escarpment dry grass forest	percentage	28%	1%	44%	11%	14%	2%
	area (ha)	4960	268	7928	1958	2516	327
dune dry shrub forest	percentage	54%	0%	20%	0%	19%	5%
	area (ha)	125	1	47	1	44	12
coastal dry shrub forest (A.floribunda)	percentage	23%	2%	33%	1%	38%	4%
	area (ha)	2923	255	4268	109	4892	524
southern riparian scrub	percentage	19%	1%	42%	1%	36%	1%
	area (ha)	47	3	102	3	88	2
northern riparian scrub	percentage	35%	1%	32%	7%	25%	0%
	area (ha)	35	1	32	7	25	0
riverine forest	percentage						
	area (ha)						
mountain dry shrub forest (E.fraxinoides)	percentage	22%	3%	31%	3%	36%	5%
	area (ha)	371	53	536	59	615	91
coastal dry shrub forest (E.obliqua)	percentage	8%	0%	34%	1%	42%	15%
	area (ha)	1745	82	6956	164	8689	3025
mountain dry shrub forest (E.cypellocarpa)	percentage	21%	0%	67%	0%	10%	2%
	area (ha)	512	2	1666	1	242	47
foothills dry shrub forest	percentage	25%	1%	41%	1%	15%	17%
	area (ha)	752	37	1252	37	461	516
mountain dry shrub forest (E.sieberi)	percentage	20%	1%	30%	10%	28%	11%
	area (ha)	368	13	550	190	513	197
lowland dry shrub forest	percentage	35%	4%	38%	3%	18%	3%
	area (ha)	4775	488	5179	389	2450	459
timbillica dry shrub forest	percentage	7%	1%	22%	1%	46%	22%
	area (ha)	1578	212	4903	226	10165	4788
eden dry shrub forest	percentage	27%	1%	29%	1%	40%	2%
	area (ha)	4449	136	4675	83	6529	372
bega dry shrub forest	percentage	19%	2%	23%	14%	37%	5%
	area (ha)	823	98	1001	610	1602	212
coastal dry shrub forest (E.agglomerata)	percentage	11%	1%	33%	1%	47%	7%
	area (ha)	3386	168	9979	357	14272	2224
genoa dry shrub forest	percentage	37%	1%	46%	0%	10%	5%

	area (ha)	891	16	1108	5	251	124
rock shrub (K.ambig)	percentage	24%	0%	52%	0%	24%	0%
	area (ha)	5	0	11	0	5	0
mountain rock scrub	percentage	21%	0%	35%	1%	41%	2%
	area (ha)	29	0	47	1	55	3
montane heath	percentage	40%	0%	49%	0%	10%	1%
	area (ha)	46	0	57	0	12	1
mountain nadgee heath	percentage	9%	0%	37%	0%	54%	0%
	area (ha)	3	0	13	0	19	0
coastal lowland heath	percentage	12%	0%	57%	0%	32%	0%
	area (ha)	15	0	74	0	41	0
swamp heath	percentage	8%	0%	31%	0%	32%	29%
	area (ha)	18	0	66	1	68	62
lowland swamp	percentage	29%	2%	25%	2%	41%	2%
	area (ha)	171	13	150	9	245	9
swamp forest	percentage	14%	1%	52%	0%	24%	9%
	area (ha)	111	6	403	3	183	66
sub alpine bog	percentage	16%	5%	26%	14%	25%	15%
	area (ha)	104	33	176	91	164	100
floodplain wetlands	percentage	22%	1%	30%	4%	40%	3%
	area (ha)	392	11	535	68	700	61
coastal scrub	percentage	48%	0%	32%	0%	17%	4%
	area (ha)	150	0	101	0	52	11
estuarine wetland (M.erci)	percentage	39%	0%	21%	4%	26%	11%
	area (ha)	74	0	40	7	49	20
saltmarsh	percentage	25%	0%	50%	0%	0%	25%
	area (ha)	3	0	6	0	0	3
estuarine wetland (Av.marin)	percentage						
	area (ha)						
wadbilliga dry shrub forest	percentage	43%	0%	31%	0%	26%	1%
	area (ha)	11116	28	7975	17	6722	145
wadbilliga range ash forest	percentage	52%	0%	24%	0%	24%	0%
	area (ha)	394	0	184	0	179	0
wadbilliga mallee heath	percentage	52%	0%	31%	0%	18%	0%
	area (ha)	620	0	367	0	211	0
wadbilliga range wet	percentage	46%	1%	37%	2%	10%	4%

forest	area (ha)	1225	24	998	67	275	96
wadbilliga gorge dry forest	percentage	32%	0%	44%	1%	23%	0%
	area (ha)	2097	30	2863	69	1506	3
wadbilliga river valley	percentage	31%	1%	43%	2%	21%	1%
forest	area (ha)	558	21	776	33	378	18

TABLE 1.2
INDICATOR 1.1- PART B (BASED ON STATE FOREST ECOSYSTEM TYPES):

vegetation ecosystem group	vegetation type name	size	current (1997) growth stage					
			candidate old growth	disturbed old growth	mature forest	disturbed mature forest	young forest	recently disturbed
rainforest	dry rf myanba euc/fig frst rocky top dry shrub frst a silve/p brogo shrub rf bunga head rf coastal warm temperate rf hinterland warm temperate rf cool temperate rf							
layered brown barrel	mtn wet layered frst *(E.nitens)* mtn wet layered frst *(E.fastigata)*	percentage	25%	4%	29%	10%	16%	16%
		area (ha)	4552	702	5310	1858	2985	2841
messmate/ gum	tantawangalo wet shrub frst mtn wet herb frst	percentage	20%	3%	33%	10%	14%	20%
		area (ha)	5958	1025	9936	2903	4106	5945
brown barrel/ gum	mtn wet fern frst basalt wet herb frst	percentage	17%	3%	31%	11%	20%	18%
		area (ha)	2266	458	4072	1418	2575	2347
southern blue gum	hinterland wet fern frst	percentage	23%	1%	44%	4%	22%	6%
		area (ha)	9447	549	17855	1529	8860	2383
yellow stringybark/ gum	hinterland wet shrub frst	percentage	17%	1%	40%	4%	31%	7%
		area (ha)	4017	258	9720	923	7466	1672
manna gum	flats wet herb frst	percentage	11%	1%	47%	18%	17%	8%

		area (ha)	271	15	1167	439	416	192
red gum	brogo wet vine frst	percentage	17%	2%	47%	4%	29%	0%
	bega dry grass frst	area (ha)	993	98	2734	249	1695	25
	candelo dry grass frst							
river peppermint	bega wet shrub frst	percentage	26%	2%	36%	5%	28%	3%
		area (ha)	2855	194	3936	527	2977	330
snow gum	monaro dry grass frst	percentage	27%	0%	56%	3%	13%	1%
	monaro basalt grass wdland	area (ha)	1192	17	2471	120	597	35
monaro grasslands/ woodlands	numeralla dry shrub wdland monaro grassland	percentage	34%	1%	36%	5%	21%	2%
		area (ha)	2370	87	2499	366	1416	164
narrow leaved peppermint	subalpine dry shrub frst	percentage	38%	3%	32%	6%	15%	6%
		area (ha)	7930	534	6559	1344	3119	1263
messmate	sandstone dry shrub frst	percentage	9%	0%	35%	1%	41%	14%
	coastal dry shrub frst (E.obliqua)	area (ha)	1932	82	7440	164	8743	3089
stringybark/ peppermint	tableland dry shrub frst	percentage	11%	1%	39%	2%	27%	20%
		area (ha)	1501	144	5551	248	3836	2866
applebox	waalimma dry grass frst	percentage	6%	3%	27%	1%	45%	19%
		area (ha)	76	35	356	8	584	253
gum/ stringybark	wog wog dry grass frst	percentage	22%	3%	41%	7%	18%	9%
	nalbaugh dry grass frst	area (ha)	11137	1299	20685	3577	8952	4422
	wallagaraugh dry grass frst							
	hinterland dry grass frst							
	escarpment dry grass frst							
	mtn dry shrub frst (E.cypellocarpa)							
woolybutt	coastal dry shrub frst	percentage	10%	2%	35%	14%	31%	7%
	(E.longifolia)	area (ha)	2290	509	7563	3004	6883	1631
yellow stringybark	coastal dry shrub frst	percentage	18%	1%	52%	1%	17%	11%
	(E.muellerana)	area (ha)	2804	113	8131	185	2622	1724
gum/box/	brogo dry shrub frst	percentage	26%	6%	29%	13%	22%	5%

stringybark		area (ha)	3213	728	3544	1580	2741	627
bangalay dunes	dune dry shrub frst	percentage	54%	0%	20%	0%	19%	5%
		area (ha)	125	1	47	1	44	12
apple	coastal dry shrub frst (A.floribunda)	percentage	23%	2%	33%	1%	38%	4%
		area (ha)	2923	255	4268	109	4892	524
riparian scrub	sthn riparian scrub nthn riparian scrub	percentage	24%	1%	39%	3%	33%	1%
		area (ha)	82	4	134	10	113	2
river oak	riverine frst	percentage						
		area (ha)						
white ash	mtn dry shrub frst (E.fraxinoides)	percentage	22%	3%	31%	3%	36%	5%
		area (ha)	371	53	536	59	615	91
silvertop ash	foothills dry shrub frst mtn dry shrub frst (E.sieberi) lowland dry shrub frst eden dry shrub frst bega dry shrub frst	percentage	29%	3%	32%	5%	27%	5%
		area (ha)	11167	772	12657	1309	11555	1756
yertchuk	timbillica dry shrub frst	percentage	7%	1%	22%	1%	46%	22%
		area (ha)	1578	212	4903	226	10165	4788
ash/ stringybark	coastal dry shrub frst (E.agglomerata)	percentage	11%	1%	33%	1%	47%	7%
		area (ha)	3386	168	9979	357	14272	2224
blue leaved stringybark	genoa dry shrub frst	percentage	37%	1%	46%	0%	10%	5%
		area (ha)	891	16	1108	5	251	124
scrub/ heath/ wetlands etc	rock shrub (K.ambig) mtn rock scrub montane heath mtn nadgee heath coastal lowland heath swamp heath lowland swamp swamp forest	percentage	23%	1%	34%	4%	32%	7%
		area (ha)	1121	63	1679	180	1593	336

	sub alpine bog floodplain wetlands coastal scrub estuarine wetland (M.erci) saltmarsh estuarine wetland (Av.marin)							
wadbilliga forests	wadbilliga dry shrub frst wadbilliga range ash frst wadbilliga mallee heath wadbilliga range wet frst	percentage area (ha)	44% 13355	0% 52	31% 9524	0% 84	24% 7387	1% 241
wadbilliga forests	wadbilliga gorge dry frst wadbilliga river valley frst	percentage area (ha)	32% 2655	1% 51	44% 3639	1% 102	23% 1884	0% 21

1.2.2 Indicator 1.2 (A type)

Extent of connectivity in the forest landscape in relation to:

i) threatened species habitat;

ii) general retained habitat on public and private land;

iii) conservation reserves.

1.2.3 Indicator 1.3 (A type)

Management measures in place to maintain species extent and abundance (Interim for first five years of the RFA).

Table 1.3 lists the available protective measures for threatened species. The measures should include processes of monitoring and information feedback on efficacy. The level of Conservation Protocols implemented in the Eden RFA will include consideration of habitat reservation and distribution of habitat across the landscape as well as the effect of disturbance and threatening processes.

TABLE 1.3
AVAILABLE PROTECTIVE MEASURES FOR THREATENED SPECIES

Protective measures	Characteristics of measure (further details in Conservation Protocols)	Species addressed	Are measures adequate for given position? Y/N
General prescriptions from Conservation Protocols	.		
Hollow-bearing tree retention	Minimum of 10 hollow-bearing trees must be retained per two hectares		
Recruitment tree retention	Minimum of 10 recruitment trees must be retained per two hectares		
Significant food	Protection of Allocasurina spp	GBC	

resources	At least 4 mature (.40 cm dbh) winter-flowering eucalypt spp per two hectares Protect mature banksia & Xanthorrhoea spp Retain all V-notch trees	YBG	
Wetlands	At least 10m buffer more than 0.1ha<0.5ha At least 40m buffer >0.5ha & SEPP 14 wetlands		
Heath	At least 20m buffer around heath >0.2ha<0.5ha At least 40m buffer around heath > 0.5ha		
Rocky Outcrops	At least 20m buffer around rock outcrops >0.1ha<0.5ha At least 40m buffer around rocky outcrops > 0.5ha		
Caves tunnels & disused mineshafts	All protected by at least 50m buffer		
Recovery Plans			
Long-footed Potoroo			
Owl Moratoria			
Species specific prescriptions???			
Plants???			

1.2.4 Indicator 1.3b (B Type)

List of representative species by extent and abundance. Representative sample to include threatened species, key functional groups and indicator species, as shown in Table 1.4.

TABLE 1.4
REPRESENTATIVE SPECIES BY EXTENT AND ABUNDANCE

Functional Group	Species considered	Estimated Population	Population Target	Suitable Habitat	Target Habitat
Hollow dependent fauna	Greater Glider (monitor wide range of pops)				
	Yellow-bellied Glider				
	Powerful Owl				
	Sooty Owl				
	Masked Owl				
Arboreal fauna	Koala				
CWR	Bush Thick-nee				
	Eastern Bristlebird				
	Brush-tailed Phascogale				

	Tiger Quoll				
	Southern Brown Bandicoot				
	Long-footed Potoroo				
	Long-nosed Potoroo				
	Brush-tailed Rock Wallaby				
	Smoky Mouse				
	White-footed Dunnart				
Carnivores	Tiger quoll				
Frogs					
Mixophes balbus	Stuttering frog				
Heleioporus australiacus	Giant Burrowing frog				
*Litoria lesueri** may have difficulty extrapolating results to threatened frogs	Leseur's frog				
Bats					
Miniopterus schreibersii	Common Bent-wing				
Falsistrellus tasmaniensis or *Scoteanax rueppellii*	Eastern False Pipistrelle or Greater Broad-nosed (to be determined)				
	Eastern Horseshoe Bat				
Birds	Red-Browed Treecreeper				
	Pink Robin				
	Olive Whistler				
	Yellow-tailed Black-Cockatoo				
	Glossy Black-Cockatoo				
	Square-tailed Kite				
	Satin Flycatcher				
	Leaden Flycatcher				
	Varied Sittella				
Plants???					
Nectivores??					
Herps???					

1.3 PRODUCTIVE CAPACITY

The productive capacity of forest ecosystems relates to the ability of those systems to grow, accumulate biomass and regenerate. Productive capacity is reliant on maintaining the functioning of forest ecosystems, in terms of water, nutrient and carbon cycling and in terms of interactions among species and the environment.

Maintenance of the forests productive capacity is important because we depend on forests directly and indirectly for a wide range of extractive and non-extractive goods and services. Their continued provision is clearly linked to the productive capacity of the forest. If this is exceeded, there is the risk of ecosystem decline. To ensure that forests continue to function, it is necessary to maintain the presence of the forest itself; to understand the levels of goods and services now provided; and to determine levels that are likely to be sustainable over long periods. The nature and degree of any changes and the factors that account for variations in productive capacity should be examined.

It is also recognized that, for various reasons, the nature of the goods and services provided from forests will change over time as a consequence of changing social and economic demands.

It is often useful to monitor changes in productive capacity as a measure of ecological processes that may be otherwise too difficult to measure. Changes in productivity or regeneration could be a signal of unforseen agents affecting ecosystems, such as nutrient depletion or global climate change. The productive capacity of an ecosystem is also related to ecosystem resilience to disturbance and stress.

1.3.1 Indicator 2.1a (A type)

Annual removal of timber products and non timber products from forest ecosystems (Table 1.5).

TABLE 1.5
ANNUAL REMOVAL OF TIMBER PRODUCTS AND NON TIMBER PRODUCTS FROM FOREST ECOSYSTEMS

product	private property		State forests	
	current actual volume	policy target volume	current actual volume	policy target volume
timber	1298 m^3		473423m^3	
native flora	unknown		(seed) 7 kg	
honey	78568 kg		78568 kg	
grazing			4 occupation permits 13 crown leases	
indigenous				
product type a	no data known		no data	
product type b			recorded	
etc				

1.3.2 Indicator 2.1b (B Type)

Annual removal of timber and non timber products from forest ecosystems compared with that estimated to be ecologically sustainable by tenure (Table 1.6).

TABLE 1.6
ANNUAL REMOVAL OF TIMBER AND NON TIMBER PRODUCTS FROM FOREST ECOSYSTEMS

product	private property		State forests	
	current actual volume	RFA target volume	current actual volume	RFA target volume
timber	1298 m^3		473423m^3	
native flora	unknown		(seed) 7 kg	
honey	78568 kg		78568 kg	
grazing			4 occupation permits 13 crown leases	
indigenous				
product type a	no data known		no data	
product type b			recorded	
etc				

1.3.3 Indicator 2.2 (C type)

Site quality and conservation of nutrients in forest ecosystems.

1.3.4 Indicator 2.3 (A type)

Standing volume of log stocks by species association and diameter class for multi-aged and regrowth native forest land available for timber production by land tenure.

Table 1.7 contains the available data on the Standing volume of log stocks by species association and diameter class for multi-aged and regrowth native forest land. Data is sourced from FRAME Technical Committee process and represents pre RFA assessment.

TABLE 1.7
STANDING VOLUME OF LOG STOCKS BY SPECIES ASSOCIATION AND DIAMETER CLASS FOR MULTI-AGED AND REGROWTH NATIVE FOREST LAND

A. Multi-aged forest

commercial species	current (1997) standing merchantable (m^3) sawlog stock		
	private property	State forest	
		< 40 cm dbh	> 40 cm dbh
silvertop ash		10700	145600
stringybarks		16000	160300
monkey gum		5400	74800
messmate		4200	69400
spotted gum		3100	12100
tableland spp		3600	76300
specials		700	3300
other		3300	39300

B. Regrowth forest

commercial species	current (1997) standing merchantable (m^3) sawlog stock	
	private property	State forest
all		

1.4 HEALTH AND VITALITY

1.4.1 Indicator 3.1 (B Type)

Lists of biological factors influencing forest health and vitality including (weeds, feral animals, insects and diseases).

Table 1.8 indicates the biological factors and control measures for NPWS, SFNSW and . Private property. Qualitative information is sourced from NPWS district pest control operators and is anecdotal rather than quantitative. Any studies of measurable extent or impact, or population densities which have been undertaken have been over restricted areas. Operational costs do not include overheads or salaries. NPWS Field Services Division have estimated the true cost to be approximately double that shown. The

information on private property was sourced from Rural Lands Protection Boards.

TABLE 1.8
BIOLOGICAL FACTORS AND CONTROL MEASURES

A. National Park & Nature Reserves

biological factor	extent	impact	control measure	level of effort ($$ 1996/7 financial year, operational costs only)**	population	measure of effectiveness	current monitoring
Rabbits	restricted areas	minor (veg. effects, soil erosion)	baiting, virus release (calici & mixo	$5 540	unknown	spotlighting to estimate density. dung counts warren activity (secondary) Vegetation monitoring (plot or photopoint)	contract Rural Lands Protection Board to monitor via spotlighting & other methods. Records not kept - aimed at targeting areas needing future pest control rather than past effectiveness
Foxes	widespread	significant (threatened spp, esp little terns, potoroos)	1080 baiting (in conjunction with dogs)	$21 250	medium - high	spotlight counts (more variable results than sand plots) * blank sand plots with lure chemicals & unpoisoned baits * trap success * bait removal	No strategic monitoring program, but records kept of numbers shot and of visits during free-feeding prior to baiting
Cats	unknown	unknown (threatened species)	trapping	$1 635	unknown	* spotlight counts * blank sand plots with lure chemicals & unpoisoned baits * trap success * bait removal	No strategic monitoring program, but records kept of numbers shot.
Dogs	widespre	not a	1080	$23 220	medium	spotlight	No strategic

	ad	NPWS priority, but control undertaken on perimeters of park to assist neighbours	baiting (in conjunction with foxes)	plus $10 000 for survey	density throughout NP interior, low on the boundaries	counts * blank sand plots with lure chemicals & unpoisoned baits * trap success * bait removal	monitoring program, but records kept of numbers shot and of visits during free-feeding prior to baiting
Pigs	widespread	moderate (soil erosion, fouling of water)	trapping, then shooting	$18 150	medium densities	* ground or aerial counts * counts at water * dung counts * surveys of pig signs * free-feeding before & after control program (quantity of bait consumed)	No strategic monitoring program, but records kept of numbers shot.
Goats	widespread	significant (soil erosion, grazing effects)	radio tracking, then shooting	$33 400	many mobs of 15 -30 animals	* aerial and ground head-counts * dung counts	No strategic monitoring program, but records kept of numbers shot.
Pines	widespread	significant, potentially large (change in veg communities, visual disturbance)	felling and basal herbicide	$3 000	medium	* Photopoints * Plots	No. Subjective visual assessment only.
Arum Lilies	restricted pockets	low (altered veg communities)	herbicide spraying (backpack)	$440	no information	* Photopoints * plots	No Subjective visual assessment only.
Blackberry	restricted areas	low (altered veg communities)	herbicide spraying (backpack)	$1 000	no information	* Photopoints * plots	No Subjective visual assessment only.
Bitou Bush	small areas in NPWS lands, adjacent to large areas on other	low, but potential (noxious weed)	hand weeding	$1 100	low	* Photopoints * plots	No Subjective visual assessment only.

	land tenures						
Tree of Heaven	small areas	minor (altered veg communities)	chop down, apply herbicide	$220	low	* Photopoints * plots	No Subjective visual assessment only.
Fireweed	restricted to disturbed areas of NPs	low (altered veg communities)	herbicide plus revegetating to shade out	$1 000	low	* Photopoints * plots	No Subjective visual assessment only.
Serrated Tussock	restricted areas adj to SF where it is a problem	minor (altered veg communities)	herbicide	$1 700	no information	* plots	No Subjective visual assessment only.
Nodding Thistle	restricted pockets	minor (altered veg communities)	herbicide	$250	low	* Photopoints * plots	No Subjective visual assessment only.
Paterson's Curse	restricted areas	minor (altered veg communities)	herbicide	$250	low	* Photopoints * plots	No Subjective visual assessment only.
Willows	remoter waterways and gullies	low, but potential (altered waterways)	helicopter survey and access to poison and chop	$2 250	low	* Photopoints * plots	No Subjective visual assessment only.
Crofton Weed	restricted to 2 areas	low, (new weed in this area & immediate program to remove) but potential for greater impact	herbicide	$150	low	* plots	No Subjective visual assessment only.
African Lovegrass	restricted	low, but C1 species	herbicide, hand weeding	$1 900	medium	* plots	No Subjective visual assessment only.
Blue Periwinkle	restricted areas	minor (altered veg communities)	herbicide	$320	low	* Photopoints * plots	No Subjective visual assessment only.
Broom	small	minor	herbicide	$270	low	* Photopoints	No

	areas	(altered veg communities)				* plots	Subjective visual assessment only.

B. State forests

biological factor	extent	accelerating cause	priority	impact	control measure	level of effort	measure of effectiveness on population
Pigs	Widespread	Hunting fraternity / no. reducing in some areas.	High	Significant (soil erosion, fouling of water, grazing effects)	Tapping, then shooting, snares.	High ($44611 1996/97)	Evidence of animals, public complaints in interface areas.
Dogs / Foxes	Widespread	Release of hunting / domestic animals.	High	Significant (prey on native animals, spread disease).	1080 baiting (using mound baiting techniques, snares, rubber jawed traps)	High ($13748 1996/97)	Evidence of animals, public complaints in interface areas.
Cats	Widespread	Ample food / release of domestics.	Low	unknown (potential prey on native animals)	testing traps and various techniques.	Low ($1068 1996/97)	Sightings, evidence of animals.
Goats	Restricted areas.	Ample food / release of domestics.	Low	Low, Grazing effects	shooting	Low	Sightings, evidence of animals.
Deer	Restricted areas.	Ample food / release of domestics.	Low	Low, Grazing effects	shooting	Low	Sightings, evidence of animals.
Rabbits	Restricted areas.	intensive logging	Low	Low, grazing effects	1080	Low	Evidence of animals.
Blackberry	Restricted areas.	-	Low	Minor, altered vegetation.	Herbicide	Low **	Evidence of weeds
Serrated Tussock	Restricted areas.	-	Low	Minor, altered vegetation.	Herbicide	Low **	Evidence of weeds
Scotch Thistle	Common	intensive logging, road edge clearing					Evidence of weeds
Nodding Thistle	Restricted areas.	-	Low	Minor, altered vegetation.	Herbicide	Low **	Evidence of weeds
Patterson's curse.	Restricted areas.	-	Low	Minor, altered vegetation.	Herbicide	Low **	Evidence of weeds

** total for 1996/97 $2591

C. Private property

biological factor	extent	acceleratin g cause	prio rity	impact	control measure	level of effort	measure of effectiveness on population
no data available within time frame for Eden RFA							

1.4.2 Indicator 3.2 (B Type)

Impact of fire on forest related values (Table 1.9)

TABLE 1.9
FIRE ACTIVITY AND JUSTIFICATION

A. State forest

WILDFIRE	**Low Intensity *** **(10 in 10 years)**	**Medium Intensity *** **(6 in 10 years)**	**High Intensity *** **(1 in 10 years)**
Area burnt (average)	200 ha	320 ha	15,500 ha
Area burnt (range)	0 - 1,000	100 - 1,500	5,000 - 26,000
Objective - the overarching objective of wildfire suppression is the "Protection of Life, Property, Assets and Environmental Values".	A lower intensity wildfire is likely to be a lesser threat to life and property and more likely to be a threat to assets and environmental values. Protection objectives would be weighted toward the protection of assets and environmental values.	A medium intensity wildfire is likely to be a lesser threat to life but a greater threat to property, forest assets and environmental values. Protection objectives would be weighted toward the protection of property, assets and environmental values.	A high intensity wildfire is likely to be a significant threat to life and property. Protection objectives would be weighted toward the protection of life and property.
Impact on water, biodiversity, property and timber.	**Water:** Some impact on mid to upper slopes where fire crosses drainage lines. Lowest chance of wildfire crossing riparian strips. May occur in only one catchment. Forest canopy intact little impact from normal rain event.	**Water:** Impact on mid and upper slopes. Fire will enter riparian strips and travel through all but the most wet forest areas. Likely to cross more than one catchment area. Forest canopy largely intact (patch scorched) some localised impact from normal rain event.	**Water:** Impact on all forested area. Fire will cross riparian strips and travel through all forested areas. Will cross more than one catchment. Nil or little forest canopy remaining, marked impact from normal rain event.

	Biodiversity: mosaic of burnt and unburnt grass and shrub layer. Limited effect on medium strata. Little effect on forest canopy. **Property:** Nil to little effect on human property or assets. **Timber:** Low level impact. Some scarring of lower boles leading to defect or infiltration point for attack and decay. Minimal crown scorch (up to 5-10m). Will impact on young regrowth.	**Biodiversity:** mosaic of burnt and unburnt grass and shrub but to a lesser extent. Will effect the medium strata and forest canopy in patches on mid to upper slope **Property:** Some risk of loss to human property and assets. Greatest risk to poorly maintained or unattended properties. Well managed with existing fire fighting equipment. **Timber:** Notable impact. Scarring of lower boles leading to defect or infiltration point for attack and decay. Full crown scorch in patches usually on mid to upper slopes. Heavy impact on young regrowth and medium strata.	**Biodiversity:** No mosaic of burnt and unburnt. Effects all strata on all slopes (lower, mid and upper). Can cause death of trees of all ages but mostly very young or senescing trees. Can create patches of even aged regrowth. Can cause localised removal of some species. **Property:** Distinct risk of loss to human life and property. Often cannot be managed using existing fire fighting equipment (or any known equipment). **Timber:** Extensive impact. Deep scarring on most of the timber, leading to defect or infiltration point for attack and decay. Full crown scorch over extensive areas of forest. Heavy impact on all forest strata and timber
Control measures to achieve objectives.	**Initial Attack:** 1. Direct - hand tools only 2. Direct - Earthmoving equipment 3. Direct - hand tools with knapsacks 4. Indirect - hand tool line, no back-burn 5. Indirect - existing roads and tracks, no back-burn **Main Suppression:** 1. Indirect - existing roads and tracks, no back-burn 2. Indirect - earthmoving machine line, no back-burn 3. Indirect - hand tool line with back-burning 4. Indirect - roads and tracks with back-burning 5. Indirect - earthmoving	**Initial Attack:** 1. Direct - earthmoving equipment 2. Indirect - roads or tracks, no back-burning 3. Indirect - roads and tracks with back-burning **Main Suppression:** 1. Indirect - existing roads or tracks, no back-burning 2. Indirect - earthmoving machine line with back-burning 3. Indirect - roads and tracks with back-burning	**Initial Attack:** 1. Indirect - roads and tracks, no back-burning 2. Indirect - roads and tracks with back-burning **Main Suppression:** 1. Passive - overnight conditions of dew or high humidity (combined with) 2. Indirect - roads and tracks with back-burning 3. Passive - previous prescribed burn 4. Indirect - earthmoving machine line, no back-burning

	machine line with back-burning		
Level of effort Average Hours	150 (hours)	320 (hours)	8,500 (hours)
Range Hours	0 - 1,100 (hours)	0 - 1,500 (hours)	7,000 - 10,000 (hours)

* The separation of wildfire into intensity classes has been done using information pertaining to the Fire Danger Rating (FDR) on the day that the fire started. The intensity of the fire is inferred from the FDR recorded. No direct measure of fire intensity is available.

B. State forest

type of prescribed burn	**Low Intensity**	**Medium / High Intensity**	**Objective**	**Impact**	**Control measures to achieve objective**	**Level of effort**
General Area Burnt (avg) (range)	7,000 ha 3,500 - 12,000 ha	NIL	The objective of general prescribed burning is to provide a mosaic of burnt and unburnt patches covering between 40-60% of the intended area. This objective can provide a range of benefits to the maintenance of biodiversity, forest health and vitality and to the protection of a valuable timber resource.	**Water**: Burning is carried out in cooler months when its less likely that a fire will run overnight or cross a riparian strip. Fire may cross a drainage line on mid to upper slopes. **Biodiversity**: A mosaic of burnt and unburnt patches in the grass and shrub layer and medium strata. **Property**: Little to no effect on adjacent property. Can benefit property protection in case of wildfire. **Timber**: Some minor scarring of lower boles is	The control measures used to achieve the burning objective are moisture differentials between the treated and untreated areas, natural boundaries and human made boundaries (roads, tracks etc).	100 ha = 12 hours 1000 ha = 35 hours plus 2 hours helicopter

				possible. Fire will sometimes climb into a trees crown if it travels up the bark of a fibrous barked tree. Has benefits in reducing the effects of a wildfire on the timber. Crown fires have been shown to fall to ground fires as the result of prescribed burning.		
Strategic Area Burnt (avg) (range)	3,000 ha 1,500 - 5,000 ha	NIL	The objective of strategic prescribed burning is to provide a mosaic of burnt to unburnt patches covering up to 80% of the intended area. Strategically placed to maximise the effectiveness of the prescription for the protection of life, property, assets and environmental values.	**Water**: Burning is carried out in cooler months when its less likely that a fire will run overnight or cross a riparian strip. Fire may cross a drainage line on mid to upper slopes. **Biodiversity**: A mosaic of burnt and unburnt patches (less than general burning) in the grass and shrub layer and medium strata. Fire will sometimes climb into a trees crown if it travels up the bark of a fibrous barked tree. **Property**: Limited effect on adjacent property or assets. Burning often done in cooperative manner between adjacent land-holders to maximise the strategic value of	The control measures used to achieve the burning objective are moisture differentials between the treated and untreated areas, natural boundaries and human made boundaries (roads, tracks etc).	100 ha = 12 hours 1000 ha = 35 hours plus 2 hours helicopter

				the prescription. Can benefit property protection in case of wildfire. **Timber**: Some scarring of lower boles is possible. Fire will sometimes climb into a trees crown if it travels up the bark of a fibrous barked tree. Has benefits in reducing the effects of a wildfire on timber quality. Crown fires have been shown to fall to ground fires as the result of prescribed burning.		
Post Logging Area Burnt (avg) (range)	3,650 ha 2,000 - 4,000 ha	700 ha 450 - 900 ha	The objective of post logging prescribed burning is to reduce fuels to a manageable level for the protection of young regrowth. This equates to reducing fine fuels by 80% and large fuels by 35%.	**Water**: Burning is contained to logged areas and is not likely to run overnight or cross a riparian strip. Fire may cross a drainage line on mid to upper slopes. **Biodiversity**: The fire will burn in a mosaic based on the area logged. **Property**: Little to no effect on adjacent property. Can benefit property protection in case of wildfire. **Timber**: Will assist in regeneration and assist in	The control measures used to achieve the burning objective are moisture differentials between the treated and untreated areas, natural boundaries and human made boundaries (roads, tracks etc).	50 ha = 15 hours

				protection of regrowth forest from wildfire.		

1.5 SOIL AND WATER

This Criterion encompasses the conservation of soil and water resources and the protective and regulatory functions of forests. Chemical, physical and biological characteristics of aquatic systems are an excellent measure of the condition and sustainability of the forests around them.

Human activities can impact on the soil surface, expose soil to erosion, and diminish productivity. Improper timber harvesting can increase the sediment load in streams, affect in-stream habitats, and compacts soils, particularly in snig tracks and log dumps. Harvesting can also increase runoff and lead to the loss of nutrients. To protect soil and maintain water quality in the southeast forests, a series of planning and operational controls, linked to the hazard of soil erosion in each area, have been implemented. Monitoring of the following indicators is designed to ensure that these controls are working well over time.

1.5.1 Indicator 4.1 (A type)

Road category density and stream crossing density by catchment for the total RFA area including forest and non forest.

Table 1.10 indicates the pre-RFA data on the density of roads and stream crossings within State Forests. Data is sourced from State Forests Corporate Roading Library Layer for Eden Management Area. This layer was made available for the RFA process. The data contained within this layer is drawn from State Forests road record's at 1:25000 scale for permanent roads only. The data does not include contractor constructed logging roads built for temporary access only and subsequently allowed to revegetate following harvesting, post log burning and regeneration surveys. Data for temporary roads is not currently available.

Table 1.11 indicates the pre-RFA data on the density of roads and stream crossings outside of State Forests. Data is sourced from Department of Lands and Water Conservation, Land Information Centre for roads in the Eden RFA. Note that due to two different digitising sets the combined data for the Eden RFA is only available as two sets and cannot be reasonably standardised. The unknown catchment type is a digitising error which did not capture a section of the catchment boundary in the north of the RFA area between the Murrumbidgee and Coastal North catchments.

TABLE 1.10
PERMANENT ROADS AND STREAM COSSINGS WITHIN STATE FOREST INCLUDING PLANTATION

Catchment	State forest	length = metres in State forest	road classification within State forest						number in State forest	stream crossings
name	area within the catchment within RFA area (ha)	density = metres per 100 hectares of State forest	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6	density = number per 100 hectares of State forest	
Bega	15726	length (m)	890	670	17500	63190	13110	69450	number	122
		density (m/100ha)	6	4	111	402	83	442	density (no/100ha)	0.8
Coastal Central	22380	length (m)	5450	1210	41380	97240	15630	149150	number	184
		density (m/100ha)	24	5	185	434	70	666	density (no/100ha)	0.8
Coastal North	17194	length (m)	6400	0	530	83810	66060	40840	number	54

		density (m/100ha)	37	0	3	487	384	238	density (no/100ha)	0.3
Coastal South	31103	length (m)	22870	0	61940	175520	21180	110010	number	254
		density (m/100ha)	74	0	199	564	68	354	density (no/100ha)	0.8
Genoa	25987	length (m)	8820	0	27310	36540	39890	54220	number	381
		density (m/100ha)	34	0	105	141	153	209	density (no/100ha)	1.5
Murrumbidgee	326	length (m)	0	0	30	0	3240	3220	number	4
		density (m/100ha)	0	0	9	0	994	988	density (no/100ha)	1.2
Snowy	21561	length (m)	330	0	12820	24230	13370	27150	number	351
		density (m/100ha)	2	0	59	112	62	126	density (no/100ha)	1.6
Towamba	38378	length (m)	15050	320	44880	119020	60310	93130	number	491
		density (m/100ha)	39	1	117	310	157	243	density (no/100ha)	1.3
Wallagaraugh	51856	length (m)	24750	0	101790	231680	11570	201690	number	434
		density (m/100ha)	48	0	196	447	22	389	density (no/100ha)	0.8
TOTAL of all State Forest in RFA area	224512	length (m)	84570	2200	308170	831210	244370	748850	number	2275
		density (m/100ha)	38	1	137	370	109	334	density (no/100ha)	1.0

Where class 1 = primary access road (all weather road, two lanes)

class 2 = secondary access road (generally all weather, one lane 4.2 to 5.5 formation width)

class 3 = feeder road (generally all weather, one lane 3.7 to 4.2 metre formation width)

class 4 = harvesting road (dry weather, natural surface, one lane, priority log haulage)

class 5 = link road (dry weather, natural surface, one lane, priority general management)

class 6 = fire trail (dry weather, natural surface, four wheel drive necessary)

TABLE 1.11
PERMANENT ROADS OUTSIDE OF STATE FOREST INCLUDING BOTH FOREST AND NON FOREST ESTATE

Catchment	area of	length = metres outside State forest	road classification outside State forest			number outside State forest	stream
name	non State	density = metres	paved roads	unpav roads ed	un-	number =	crossings

	forest within the catchment within RFA area (ha)	per 100 hectares of land outside of State forest	>=2 lanes	1 lane	>=2 lanes	1 lane	known	number per 100 hectares of land outside of State forest	
Bega	194061	length (m)	280610	17090	82220	337870	21000	number	1980
		density (m/100ha)	145	9	42	174	11	density (no/100ha)	1.0
Coastal Central	37427	length (m)	170590	10120	28850	67810	42850	number	529
		density (m/100ha)	456	27	77	181	114	density (no/100ha)	1.4
Coastal North	71384	length (m)	79980	7960	28200	73750	10120	number	417
		density (m/100ha)	112	11	40	103	14	density (no/100ha)	0.6
Coastal South	32754	length (m)	17410	0	80	33280	170	number	104
		density (m/100ha)	53	0	0	102	1	density (no/100ha)	0.3
Genoa	26455	length (m)	9030	0	14410	57610	41430	number	84
		density (m/100ha)	34	0	54	218	157	density (no/100ha)	0.3
Murrumbidgee	44563	length (m)	11240	0	30550	50740	1160	number	383
		density (m/100ha)	25	0	69	114	3	density (no/100ha)	0.9
Snowy	111327	length (m)	9830	5570	39750	231030	41240	number	1119
		density (m/100ha)	9	5	36	208	37	density (no/100ha)	1.0
Towamba	64541	length (m)	27780	2360	68040	87910	35260	number	569
		density (m/100ha)	43	4	105	136	55	density (no/100ha)	0.9
Wallagaraugh	7189	length (m)	10520	1130	0	3050	0	number	14
		density (m/100ha)	146	16	0	42	0	density (no/100ha)	0.2
unknown	138								
TOTALS of all	589739	length (m)	705460	44220	292120	943030	193220	number	5199
non State forest in RFA area		density (m/100ha)	120	7	50	160	33	density (no/100ha)	0.9

1.5.2 Indicator 4.2 (B Type)

Changes to macro-invertibrate diversity in streams.

1.5.3 Indicator 4.3 (C type)

Extent and proportion of physical disturbance from harvesting and fire (Table 1.12).

TABLE 1.12
EXTENT AND PROPORTION OF SOIL EXPOSED BY DIFFERENT HARVESTING PRACTICES (PRELIMINARY, SUBJECT TO RESEARCH EVALUATION).

harvest system	sub soil exposed on general harvest area, snig tracks, dumps & internal logging roads (% of net harvest area)		top soil exposed on general harvest area (% of net harvest area)		total exposure of soil including top soil exposed on snig tracks, dumps and internal logging roads (% of net harvest area)	
	average	maximum	average	maximum	average	maximum
A1	2	5	0	2	2	8
A2	3	7	0	3	4	11
B0	3	8	0	5	4	14
B1	3	10	1	10	5	20
B2	3	15	1	10	5	25
B3	12	20	4	10	20	40
C1	15	25	10	15	30	55
C2	5	8	5	8	10	16

1.5.4 Indicator 4.4 (B Type)

Proportion of catchment likely to be harvested from 1997-2019 by harvest system as an immediate proxy determination of possible influence on water quality.

Table 1.13 indicates the proportion of catchment likely to be harvested from 1997-2019 by harvest system.

TABLE 1.13
PROPORTION OF CATCHMENT LIKELY TO BE HARVESTED FROM 1997-2019 BY HARVEST SYSTEM

Catchment name	total Catchment size within RFA area (ha)		Harvested forest by harvest system from 1997-2019								
			Light Intensity		Moderate Intensity			Intensified Intensity			
			Light selective logging (A1)	Medium selective logging (A2)	Small group selection (B0)	Group selection (B1)	Patch cutting (B2)	Extensive tree removal (B3)	Intensive logging (C1)	Regrowth thinning (C2)	total
Bega	209787	area (ha) proportion									
Coastal	59807	area									

Central		(ha) proportion									
Coastal North	88578	area (ha) proportion									
Coastal South	63857	area (ha) proportion									
Genoa	52442	area (ha) proportion									
Murrumbidgee	44889	area (ha) proportion									
Snowy	132888	area (ha) proportion									
Towamba	102819	area (ha) proportion									
Wallagaugh	59045	area (ha) proportion									
TOTAL	814251	area (ha) proportion									

1.5.5 Indicator 4.5 (B Type)

Assess the change in the level of growth stages from 1997-2019 by catchment as an immediate proxy rating of water quantity.

Table 1.14 indicates the current (1997) gross area in hectares , within catchments by growth stages. Data is sourced from the Environment and Heritage Technical Committee produced layer of broad catchment zones and the FRAMES Technical Committee produced layer of growth stages. Refer to the Environment and Heritage Technical Committee growth stage project for specifications on attributes for each growth stage.

The unknown catchment type is a digitising error which did not capture a section of the catchment boundary in the north of the RFA area between the Murrumbidgee and Coastal North catchments.

TABLE 1.14
1997 GROSS AREA (HA) WITHIN CATCHMENTS BY GROWTH STAGES

Catchment name	current (1997) gross area within catchments by growth stages (hectares)							
	rainforest	old growth	old disturbed	mature	mature disturbed	young forest	recently logged	cleared
Bega	4023	29200	2149	42439	7193	25670	4246	94867
Coastal Central	932	7410	693	21567	789	9554	3459	15404
Coastal North	2567	21051	1739	16393	4358	7278	2018	33177
Coastal South	901	10344	439	14262	81	26703	2244	8883
Genoa	84	5695	526	15497	482	7441	6221	16497
Murrumbidgee	0	6008	149	7452	349	2271	505	28155
Snowy	0	5123	741	8847	4408	7270	6184	100316
Towamba	1561	16454	1965	28244	5036	15963	6785	26811
Unknown		0		52			2	83
Wallagaraugh	557	4738	275	17379	496	23021	10743	1836

1.6 ECONOMIC AND SOCIAL

A prevailing feature of forests is that they are renewable and, with management regimes that retain their ecological integrity and adaptive capacity, can be sustained in perpetuity. Historically, population growth and development pressures have resulted in the conversion and loss of forest land to other uses and in some cases degradation of forest ecosystems. In addition, there has been a tendency to focus on the extraction of timber and the management of the forest land base to maximize timber production. The adoption of ecologically sustainable forest management as a goal, however, has significant implications for the use and management of forests of the Eden RFA region. Sustainable management implies:

- that land tenures and management plans will provide greater recognition of the non-timber forest goods and services;
- that the needs of future generations will be considered in decisions regarding the use, management and conservation of forests;
- that equity in rural forest based communities, rights of Indigenous peoples and impacts on employment will be considered in decision making;
- a greater degree of integration of economic and environmental objectives in decision making.

The ability to continue to deliver goods and services requires the maintenance of the forest land base and of forest ecosystem processes. Ecologically sustainable forest management also includes economic development and the value of forests as an economic resource. Economic development provides a diverse range of goods and services:

- timber products and the revenues from their sale;
- economic benefits from the conversion and sale of timber into forest products including employment, incomes, and profits;
- economic benefits from recreation, eco-tourism, private campgrounds, tourism lodges, etc:
- use of the forest to obtain subsistence products, such as food and firewood, and for gathering of nuts, berries, botanical products and medicinals;
- benefits to people with permanent or temporary residences in forest areas; and

- values associated with the knowledge that a) particular rare and threatened forest flora and fauna are being protected and will continue to exist, b) forests are being conserved for future generations, and c) the option to undertake a certain type of activity in the future is available. This group of values is part of the important class of values called 'passive use' or 'non-use' values.

Production of goods and services occurs by combining inputs of forest resources, labour, capital, and various intermediate products. For example, forest productivity can be enhanced by investing in silviculture and protection. The economic benefits associated with harvesting of forests are dependent on the level of investment. Many forest based economic benefits either would not be available or would be available at lower levels without investment in processing. Investment will occur if there is some economic incentive or motivation to invest. The supply of benefits from the forest resource is therefore dependent on the level of investment, and this in turn is based on the expected return from the investment.

Equity, social justice and cultural values are important aspects of ecologically sustainable development. The practices of forest management and utilisation are generally rural based activities. Rural economies and rural communities are distinct and face unique challenges compared to urban communities. The economies of rural forest based communities often have difficulties in adapting to rapidly changing economic circumstances. Many of these changing circumstances are also driven by events or decisions made outside the rural communities or the forest sector. Indigenous societies also have unique ties, values and knowledge of forest use and management. Strict reliance on the principles of economic efficiency and maximization of economic wealth may result in residents of forest based communities incurring a disproportionate share of the cost of economic change.

1.6.1 Indicator 5.1 (A type)

Mean volume and royalty value of logs harvested per annum by species and grade by tenure (Table 1.15).

TABLE 1.15
VOLUME AND ROYALTY OF LOGS HARVESTED

A. State forests 1996 sales

grade	log species	(%)	volume (m^3)	royalty ($)
quota sawlog	silvertop ash	25		
	stringybarks	21		
	monkey gum	6		
	messmate	3		
	spotted gum	< 1		
	tableland spp	39		
	specials	< 1		
	other	4		
	total		37034	1181972
ex-quota sawlog	silvertop ash	28		
	stringybarks	16		
	monkey gum	5		
	messmate	3		
	spotted gum	1		
	tableland spp	28		
	specials	< 1		

	other	18		
	total		1227	19273
pulp log - multi-aged forest + thinning	mixed		434200	8684000
poles (1997)	woolybutt	100	10	414
firewood	mixed		800	5206
fencing	mixed durable		146	4289
landscape	mixed durable		6	137

B. Private property recorded sales 1996

log type	volume (m^3)	royalty ($)
sawlog	1000	not determined
pulp log	298	not determined

1.6.2 Indicator 5.2 (B type):

Total volume, value of products and production, and flow-on economic contribution compared to cost of production for all products (Table 1.16)

TABLE 1.16
VOLUME AND VALUE OF PRODUCTS

Product	Tenure	Volume (m3)	Royalty ($)	value of product and production ($)	economic contribution ($)	cost of production ($)
timber - hardwood	SFNSW private land	37,700 j 1,000	1,263,000 b 25,000	5,800,000		3,858,833 g
timber - softwood	SFNSW private land	80,700 k ?	1,257,000 l ?			
pulp - hardwood	SFNSW private land	434,200 298	8,684,000 ?	41,300,000		
pulp - softwood	SFNSW private land	0 0	0 0	0 0	0 0	0 0
native flora	SFNSW NP private land	7 kg seed	162			
water	SFNSW NP private land					

	Total	18,200 ML				
honey	SFNSW NP private land Total	78,568 kg - 78,568 kg 157,136 kg	1851 - royalty ??? 	129,638 - 129,638 259,276	 - 481,026	 169,000
grazing	SFNSW NP private land	240 head -	3374 - ?????			
extractive industry & mining	SFNSW DMR NP private land		38536 1,161,000 ? - 3,600,000		 -	
	Total		4,800,000 e		7,500,000 f	
indigenous	SFNSW NP private land					
recreation	SFNSW NP private land	16,100 506,600 	16781 - 	323,610 - 404,593 i 10,182,660 - 12,730,858 i 	77,280 - 305,900d 2,431,680 - 9,625,400d -	72,500 1,352,000 c -

b includes quota and salvage log grades

c estimated 52% of overall $2.6m expenditure and employment primarily associated with tourism and recreation

d estimates of consumers' surplus associated with visits to forested lands using a range of $4.80 & $19.00 per visit

e annual value developed using records for 1994/95 & 1995/96. Of total 70% hard rock aggregate, 20% unprocessed road materials and remainder sand, loam and prophyllite. Value considered to be greater due to lack of records for some operators.

f sourced from ' Outlook for mining in the Eden Study Area' - DRAFT

g - commercial expenditure (associated mainly with timber production and other forest product sales) for the Eden Management Area

h - total of $273,000 includes $13,357 of wax production - not tenure specific.

i - using expenditure per visit of $20.10 and $25.13 data multiplied by 506,000 visits to NP's and 16,100 visits to SF's

j - composed of 36,700 quota and 1,000 salvage.

k - composed of 46,500 sawlogs and 34,200 preservation roundwood.

l - composed of $744,000 sawlog and $513,000 preservation roundwood.

1.6.3 Indicator 5.3 (B type):

Availability and uses of recreational/tourism facilities (Table 1.17).

TABLE 1.17
FOREST ORIENTED RECREATIONAL OPPORTUNITIES IN STATE FORESTS AND NATIONAL PARKS OF THE EDEN RFA REGION

A. Forest orientated recreational opportunities in State Forests of the Eden RFA.

RECREATIONAL FACILITY NAME	STATE FOREST	OPPORTUNITY TYPE	NO. OF CAMP SITES, DISTANCE OF TRACKS, ETC.	ESTIMATED USAGE RATES
Bermagui Picnic Area	Bermagui SF	Picnics, walks	walking trail	2000 pa
Rockton Falls	Rockton SF	Picnics, waterfall	Table , BBQ	500 pa
Nalbaugh Falls	Bombala SF	Picnics, waterfall	Tables, BBQ	100 pa
Newtons crossing	Proposed Wallagaraugh Flora Reserve	Camping, picnicking	3 campsites, 2 BBQ, 2 tables, toilet, water tank, bins.	200 pa day 150 pa o/night.
Fisheries beach	Twofold Bay	Beach related opportunities only	10 campsites.	1500 pa day 1000 pa o/night.
Scrubby Ck.	East Boyd SF	O/night van use/ picnicking.	Parking area for over night van use (5 vans), 2 toilets, 2 BBQ, 4 tables, water tank, bins, Interps shelter.	2000 pa day 1500 pa o/night.
Burrawang	East Boyd SF	Picnicking/ walk access.	2 tables, water tank, toilet, 2 BBQ, Interps shelter, access to 2.5 km walk up m. Imlay (one way).	2000 pa
Broadwater	Broadwater Road	Picnicking/ swimming	2 tables, BBQ, bin. Access to swimming hole in Yowaka River.	300 pa
Maxwell's Rainforest Walk & Picnic Area	Nadgee SF	Picnicking/ R/forest walk.	3 BBQ, 3 Tables, Water Tank, Bins. Access to 1.5km R/forest walk, Interps shelter.	1000 pa
Ludwigs Ck.	Nadgee SF	Picnicking.	2 BBQ, 3 Picnic Tables, Toilet, Bins.	100 pa
Pambula River.	Nethercote	Picnicking.	BBQ, 3 Tables, Bins.	100 pa

	Rd			
Imlay Ck.	Imlay Rd	Picnicking.	BBQ, 2 Tables, Toilet, Bins.	200 pa
Nethercote Falls	Nethercote Falls Flora Reserve	Picnicking/ swimming	Bin, 200m track to falls.	1000 pa
Allan Brook	Allan Brook Rd	picnicking / swimming.	BBQ, Bin.	50 pa
Wallagaraugh Forest Drive.	Nadgee SF	Drive / Picnicking.	Approx. 25 km drive (from highway to highway).	2000 pa
Myrtle Mountain		Picnicking / lookout.	Toilet, 3 BBQ, 4 Tables, Bins, view over Bega Valley.	1000 pa
Goodenia Rd.	Interim Forest Area - Yurammie	Picnicking / R/forest walk.	Walking track through R/forest approx 700m, BBQ.	50 pa
Wonboyn River	Bull Creek Forest Road	Fishing / Camping	Open Camping	medium usage
		4WD tours (contract)		50 to 70 tours pa
		4WD tours (SF)		10 to 15 tours pa
		Rallies (car)		1 pa
		Rallies (cycle)		1 pa
		Horse tours		10 to 20 tours pa

B. Forest oriented recreational opportunities in National Parks of the Eden RFA Region.

Recreational Facility Name	**Opportunity Type**	**Facilities, no. of camp sites, dist. of trails**	**Usage Rates**	**Source of Vis. Nos.**
Wallaga Lake NP			500	1994 figures
Mumbulla Creek Picnic Area, Biamanga NP	Swimming, picnics, waterfall	toilet, BBQ, tables	20,000	Estimate
Mimosa Rocks NP	**Beach opportunities only**			
Bournda NP			100,000	Traffic counter
Kangarutha Track	Bushwalking	9km walk track one way		
North Tura	Lookout, bush walking	Toilet, disabled access to lookout	40,000	Traffic counter

Ben Boyd NP	**Beach opportunities only**			
Nadgee Nature Reserve	Wilderness	Track head for wilderness walk, toilet, BBQ	12,000	Traffic counter
Wilderness Walk	3-4 day walk in wilderness	Nil	2,000	Permits
Mt Imlay NP - Walk			1,000	1994 figures
South East Forests NP				
Pipers Lookout-Bemboka	Short walk, views, lookout, picnic	Composting toilet, tables, disabled	many	
Myrtle Mountain Lookout-Yurammie	Views, picnics	BBQ, table, toilet	1,000	Conservative estimate
Wolumla Peak	500m walk to lookout, picnics	BBQ, table, toilet	1,000	Conservative estimate
Six Mile Creek walk-Tantawangalo	Short walk from Rest Area to waterfall	Car park, toilet, BBQ, tables, interps.	8,000	Estimate
Big Jack Rest Area-Coolangubra	Picnic, short walks	Interps, BBQ, tables, disabled	300	Estimate
White Rock River Rest Area-Genoa	Walk along riverbank, picnic	Interps, BBQ, tables, toilets, disabled	800	Estimate
		Total	186600	

1.6.4 Indicator 5.4 (A type)

Employment numbers by type across all forest users in Eden region.

Table 1.18 indicates the employment numbers by type. Figures for sawmilling, woodchips and harvest and hauling represent FORUM data for Reference Point 1 - current tenure, 28,700m3.

TABLE 1.18
EMPLOYMENT NUMBERS BY TYPE

employee division	current (1997) employment percent					number of employees	full time equivalent
	ABS salary range						
	< $12k	$12k - $25k	$25k - $40k	$40k - $60k	$60k +		
hardwood - sawmilling [a]		5%	73%	22%		30	
hardwood - woodchips		7%	57%	22%	14%	46	
hardwood - harvest & hauling	1%	9%	52%	33%	5%	104	

[b]						
hardwood - forest management			83%	17%		60
conservation management		9%	67%	19%	5%	33
other non timber products						
urban water production						?
hydro-electricity generation						*4*
dairy production [c]						?
dairy manufacture [c]						?
apiary						10 3
mining and extractive industry						?
tourism/recreation						?

a - Tablelands Sawmills in Cooma & Bombala.

b - Incorporates SAU categories 'Bush Workers, Haulage Contractors, Contractors, Truck Drivers and Additional Employees'.

c - Increment attributable to irrigation with water derived from forest catchments.

1.6.5 Indicator 5.5 (B type):

Gross income index (Table 1.19).

TABLE 1.19
GROSS INCOME INDEX

ABS statistical local areas (SLA) for 1996	Area (sq. kms)	gross annual income	
census		gross community	forest sector
Bega Valley Shire	6281	$ 209,688,024	$7,814,976
Bombala Shire	1933	$ 26,228,280	$ 5,232,864
Total	8214	$ 235, 916, 304	$ 16,958,340 *

* includes value of $3,910,500 gross income of NPWS and SFNSW hardwood employees in the Eden RFA Region. Derived from DPIE Social Assessment Unit data collected as part of the Eden RFA.

1.7 CULTURAL AND HERITAGE

The concept of ecologically sustainable forest management transcends biological, ecological, and economic benchmarks. It is about society's values and needs and the cultural and spiritual connections of society to the forest. These cultural and spiritual connections and needs can vary substantially even among communities within a region. For example, the spiritual and cultural needs and values of Indigenous peoples are unique and distinct. The spiritual and cultural value of natural forests to people who live in urban environments may be quite different but equally important. These indicators consider the cultural, social and spiritual values from two perspectives. First, they consider how actions are taken to protect and manage forest lands in order to protect and preserve social and cultural values. Second, they consider the psychological values associated with non-consumptive and passive use activities.

1.7.1 Indicator 6.1 (A type)

Change in condition and number of recorded places, artefacts, sites, buildings or other structures.

Table 1.20 indicates the non-indigenous cultural heritage (National Estate and state heritage value) sites**.** This information should be considered indicative only, as detailed assessments and documentation of places are yet to be finalised. Current condition of places identified has not been able to be stated as detailed information on places has yet to be received. All places identified as having historic value should be considered as indicative only assessment against National estate and State heritage criteria is yet to be undertaken.

TABLE 1.20
NON-INDIGENOUS CULTURAL HERITAGE (NATIONAL ESTATE AND STATE HERITAGE VALUE) SITES

Heritage Feature (Place Name)	National Estate /State Heritage Value	Location	Tenure	Threatening Processes	Current Protective Mechanisms	Management Implications for SFNSW	Resource Implications
Old Growth Forest Patches - Kingfisher Road, Myrtle Mt, Wolumla Peak	Social Aesthetic	Indicative only Yurrammie SF	SFNSW	Fire Logging Silviculture	PMP 1.2	Nil logging, Nil silviculture Nil fire	Nil currently excluded from logging
Panbula Goldfield	Social Historic Aesthetic	Nullica SF	SFNSW	Fire Mining Logging Silviculture	PMP 1.1.8 Heritage Act 1977 AHC Act 1975	Forest management by prescription - light intensity logging, nil fire.	Nil additional impact on resource - area already identified and managed as PMP 1.1.8 Forest management by prescription and has conservation plan
Goodenia Rainforest	Aesthetic	Yurrammie SF	SFNSW	Fire Logging Silviculture	Rainforest	Classification as PMP 1.1.6 & 1.1.2 Maintenance of viewing lines	Moderate impact on surrounding eucalypt forest
Tannery Site, Gnupa SF	Potential Historic	Gnupa SF	SFNSW	Fire Logging Silviculture	Heritage Act 1977	Classification as PMP 1.1.8 Forest management by prescription - light intensity logging, nil fire	Moderate - conservation of representative area of forest around site sought, needs to be clearly delineated, included in PMP and managed by prescription

Yambulla Goldfields & Township	Potential Historic	Yambulla SF	SFNSW	Fire Mining Logging Silviculture	Heritage Act 1977 PMP 1.1.8 PMP 1.2 PMP 1.3 PMP 1.1.7	Additional classification of significant areas as PMP 1.1.8 Forest management by prescription - light intensity logging, nil fire	Substantial - some areas within area delineated currently PMP 1.1.8 Forest management by prescription, 1.2 excluded from harvesting, 1.3 excluded from harvesting, and 1.1.7 excluded from harvesting
Whipstick mines and village site	Historic	Gnupa SF	SFNSW	Fire Mining Logging Silviculture	Heritage Act 1977	Classification of significant areas as PMP 1.1.8 Forest management by prescription - light intensity logging, nil fire	Moderate - needs to be clearly delineated, included in PMP and managed by prescription
Hites Waterwheel Sawmill Site & Rockton Falls	Social Aesthetic Potential Historic	Bondi SF	SFNSW	Fire Logging Silviculture	Stream side reserve	Classification as PMP 1.1.2	Nil, currently protected by stream side buffer and excluded from harvesting.
Murrah State Forest (koala habitat)	Social Aesthetic	Indicative only Murrah SF	SFNSW	Fire Logging Silviculture	unknown		
Myrtle Mountain Lookout	Social Aesthetic	Tantawangalo SF	SFNSW	Fire Logging Silviculture	PMP 1.1.2	Nil logging, Nil silviculture Nil fire Maintain access	Nil, currently PMP 1.1.2 and excluded from harvesting.
Wallaga Lake	Social Aesthetic	Bermagui SF	SFNSW, Crown land & NPWS	Fire Logging Silviculture	PMP 1.1.6	Forest management by prescription - light intensity logging, nil fire Maintenance of viewing lines	Moderate impact on resource due to extensions of PMP 1.1.6 boundary outside current delineated area than currently exist
Davidson's Whaling Station	Social Historic Aesthetic	East Boyd SF / Ben Boyd NP	NPWS & SFNSW	Fire Logging Silviculture	Heritage Act 1977 AHC Act 1975 NPW Act 19 PMP 1.1.6	Forest management by prescription - light intensity logging, nil fire	Nil - no change to current management

Cow bail trail / Chimneys trail / cuttings	Historic Aesthetic	Coolangubra SF	NPWS & SFNSW	Fire Logging Silviculture	Heritage Act 1977 NPW Act 19 PMP 1.1.6	Classification of entire area as PMP 1.1.6 Forest management by prescription - light intensity logging, nil fire	Moderate - 5m buffer for pine areas within State Forest, 20m buffer for native forest areas within State Forest - requires identification as PMP 1.1.6 harvesting by prescription
Edrom Lodge	Historic Aesthetic	East Boyd SF	SFNSW	Fire Logging Silviculture	Heritage Act 1977 PMP 1.1.3	Additional classification as PMP 1.1.8 and PMP 1.1.6 Forest management by prescription - light intensity logging, nil fire Maintain historic values Maintain viewing lines	Nil, currently PMP 1.1.3 education harvesting by prescription.
Burrawang Picnic Ground	Aesthetic	East Boyd SF	SFNSW	Fire Logging Silviculture	PMP 1.1.2 PMP 1.1.6	Forest management by prescription - light intensity logging, nil fire Maintain viewing lines	Nil - no change to current management.
Fisheries Beach walk	Aesthetic	East Boyd SF	SFNSW	Fire Logging Silviculture	PMP 1.1.6	Forest management by prescription - light intensity logging, nil fire Maintain viewing lines	Nil -. no change to current management
Ludwigs Creek	Aesthetic	Nadgee SF	SFNSW	Fire Logging Silviculture	PMP 1.1.7	Additional classification as PMP 1.1.6 Maintenance of value Maintenance of viewing lines	Nil - contained within current PMP 1.1.7 boundary and excluded from harvesting
Maxwells forest walk	Aesthetic	Maxwells Flora Reserve	SFNSW	Fire Logging Silviculture	PMP 1.3	Additional classification as 1.1.6 Maintenance of value Maintenance of viewing lines	Nil - contained within current forest preserve and excluded from harvesting

Newtons Crossing camping area	Aesthetic	Wallagaraugh Reserve, Timbillica SF	SFNSW	Fire Logging Silviculture	PMP 1.1.7	Additional classification as 1.1.6 Maintenance of value Maintenance of viewing lines	Nil - contained within current PMP 1.1.7 boundary and excluded from harvesting
Scrubby Creek picnic area	Aesthetic	East Boyd SF	SFNSW	Fire Logging Silviculture	PMP 1.1.6 PMP 1.1.2	Forest management by prescription - light intensity logging, nil fire Maintenance of viewing lines	Nil - no change to current management
Nethercote Falls	Aesthetic	Nethercote Flora Reserve	SFNSW	Fire Logging Silviculture	PMP 1.3 AHC Act 1975	Additional classification as PMP 1.1.6 Maintenance of value Maintenance of viewing lines	Nil - current flora reserve, excluded from harvesting
Nalbaugh Falls	Aesthetic	Nalbaugh SF	SFNSW	Fire Logging Silviculture	PMP 1.1.7 PMP 1.1.2	Additional classification as PMP 1.1.6 Forest management by prescription - light intensity logging, nil fire Maintenance of viewing lines	Nil - no change to current management
Wog Way Forest Drive	Aesthetic	Bondi / Coolangubra SF	NPWS & SFNSW	Fire Logging Silviculture	PMP 1.1.6	Forest Management by prescription - light intensity logging, nil fire Maintenance of value Maintenance of viewing lines	Moderate - extent of buffer.
Montreal Goldfields	Potential Historic	Bermagui SF	SFNSW, Crown Land & Private	Fire Mining Logging Silviculture	Heritage Act 1977	Classification as PMP 1.1.8 Forest management by prescription - light intensity logging, nil fire	Mostly private & crown land issue, if determined to be partly on State Forest may require PMP
Prison Farm, Bondi SF	Potential Historic	Bondi SF	SFNSW	Fire Logging Silviculture	Heritage Act 1977	Classification as PMP 1.1.8 Maintenance of value	Nil - on cleared land within pine plantation

Quarry Site	Potential Historic	Nalbaugh SF	SFNSW	Fire Logging Silviculture	Heritage Act 1977	Unrestricted forestry	Nil - no change to current management practices
Razor-back Fire Trail	Potential Historic	Murrabrine SF	SFNSW & NPWS	Fire Logging Silviculture	Heritage Act 1977	Unrestricted forestry	Nil - no change to current management practices
Sleeper cutter camps, Murrah SF	Potential Historic	Murrah SF	SFNSW	Fire Logging Silviculture	Heritage Act 1977	Classification as PMP 1.1.8 Forest management by prescription - - light intensity logging, nil fire	Negligible - needs to be clearly delineated included in PMP and managed by prescription
Wolumla goldfield	Potential Historic	Yurrammie SF	SFNSW, and possibly some private	Fire Mining Logging Silviculture	PMP 1.1.6	Classification as PMP 1.1.8 Forest management by prescription - - light intensity logging, nil fire	Potentially substantial if entire boundary as delineated applied - some of the area is currently PMP 1.1.6 harvesting by prescription
Woolingubrah Inn	Potential Historic	Coolangubra SF	SFNSW	Fire Logging Silviculture	Heritage Act 1977	Classification as PMP 1.1.8 Forest management by prescription - - light intensity logging, nil fire	Potentially substantial on pine resource) if buffer suggested is considered, site currently has 50 - 100m buffer.
Tantawangalo Road and Lookout	Aesthetic Potential Historic	Glen Bog SF	SFNSW & NPWS	Fire Logging Silviculture	PMP 1.1.6	Additional classification as PMP 1.1.8 Forest management by prescription - - light intensity logging, nil fire Maintenance of viewing lines	Nil - moderate if it is proposed that current management prescriptions be changed - within current PMP 1.1.6 boundary harvesting by prescription

1.7.2 Indicator 6.2 (C type):

Level of participation in decision making process post RFA encompassing indigenous and non indigenous issues related to forest management.

APPENDIX 1
Principles of Ecological Sustainable Management

There have been significant advances in forest policy at international, national and State levels in recent years. The central theme of these policy developments has been related to the concept of ecologically sustainable forest management (ESFM). Both the Commonwealth and NSW governments have committed to implementing ESFM as part of the Eden RFA. The following principles are designed to bring together the policies relating to forest conservation and management, so as to provide guidance to forest land managers. These principles have been the basis for identifying performance indicators, operational practices and conservation protocols for the Eden RFA.

PRINCIPLE 1 MAINTAIN OR INCREASE THE FULL SUITE OF FOREST VALUES FOR PRESENT AND FUTURE GENERATIONS ACROSS THE NSW NATIVE FOREST ESTATE

- The principle of intergenerational equity (that in meeting the needs of the present generation, the ability of the future generations to meet their own needs is not compromised) is embodied in this principle.
- Ensure that ESFM at the regional and smaller scales is implemented by ecologically appropriate planning and operational practices, and that ESFM targets are set and indicators of performance are monitored.
- Ensure the long-term maintenance of the full range of values of the NSW existing forest estate. The intention is to maintain or increase not only the full range of values, but also the magnitude or level at which those values are maintained or increased**.**
- Encourage the increased production of plantation-grown timber and the social and economic benefits flowing from this increased production to supplement the wood supply from native forests.

Aims include

A Biodiversity

- biological diversity of forests at the ecosystem, species and genetic levels where biological diversity includes natural patterns of ecosystems, species and gene pools in time and space.
- Address the requirements of vulnerable species, assist with the recovery of threatened species, and maintain the full range of ecological communities at viable levels.
- Protect landscape values including by the careful planning of operations and the reservation of appropriate patches and corridors of vegetation.

B The productive capacity and sustainability of forest ecosystems

- maintain ecological processes within forests (such as the formation of soil, energy flows and the carbon, nutrient and water cycles, fauna and flora communities and their interactions)
- maintain or increase the ability of forest ecosystems to produce biomass whether utilised by society or as part of nutrient and energy cycles
- ensure the rate of removal of any forest products is consistent with ecologically sustainable levels
    - ensure the effects of activities/disturbances which threaten forests, forest health or forest values are benign.

C Forest ecosystem health and vitality

- reduce or avoid threats to forest ecosystems from introduced diseases, exotic plants and animals, unnatural regimes of fire or flooding, wind shear, land clearing and urbanisation

- promote good environmental practice in relation to pest management
- ensure the effects of activities/disturbances within forests, their scale and intensity, including their cumulative effects are controlled and benign
- restore and maintain the suite of attributes (ecological condition, species composition and structure of native forests) where forest health and vitality have been degraded.

D Soil and water

- maintain the chemical and biological functions of soils by protecting soils from unnatural nutrient losses, exposure, degradation and loss
- maintain the physical integrity of soils by protecting soils from erosion, mass movement, instability, compaction, pulverisation and loss
- protect water quality (physical, chemical, biological) by measures controlling disturbance resulting from forest activities
- identify and maintain at appropriate levels, water yield and flow duration in catchments.

E Positive contribution of forests to global geochemical cycles

- Maintain the positive contribution of forests to the global geochemical cycle (includes climate, air and water quality and deposition)

F Long-term social and economic benefits

- maintain and enhance, on an ecologically sustainable basis, production of wood and wood products, including value adding, investment and resource security
- provided it is ecologically sustainable, set, maintain or enhance the level of use of non-wood products and uses, including bee-keeping, grazing, mining, recreation and tourism, reliable water supply
- maintain and enhance, on an ecologically sustainable basis, the provision of employment and community needs such as economic diversification, investment skills, education, jobs stability, training and indigenous needs
- encourage the establishment and use of plantation forests on existing cleared land to expand social and economic values
- maintain and enhance the intangible social welfare benefits which forests provide.

G Natural and cultural heritage values

- protect social, natural and cultural heritage values and sites, including aesthetic, landscape, historic, cultural, educational, scenic spiritual and scientific values, including indigenous values and sites.

PRINCIPLE 2 ENSURE PUBLIC PARTICIPATION, ACCESS TO INFORMATION, ACCOUNTABILITY AND TRANSPARENCY IN THE DELIVERY OF ESFM.

- ensure public participation in decision-making processes at local, regional and State and Federal levels
- ensure comprehensive, timely and reasonable public access to information

- ensure transparency[1], openness[2] and accountability[3] in decision making processes and performance.

PRINCIPLE 3 ENSURE LEGISLATION, POLICIES, INSTITUTIONAL FRAMEWORK, CODES, STANDARDS AND PRACTICES RELATED TO FOREST MANAGEMENT REQUIRE AND PROVIDE INCENTIVES FOR ECOLOGICALLY SUSTAINABLE MANAGEMENT OF THE NATIVE FOREST ESTATE.

- establish a process for shared management and administration, recognising the customary and traditional rights of indigenous people, and the interests of private land-holders and other stake-holders in an area's management

PRINCIPLE 4 APPLY PRECAUTIONARY PRINCIPLES FOR PREVENTION OF ENVIRONMENTAL DEGRADATION

- The incorporation of the precautionary principle into decision making has been endorsed by State and Commonwealth Governments (Commonwealth of Australia 1992 p. 49, IGAE 1992) and is defined as 'where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:
  - careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment; and
  - an assessment of the risk-weighted consequences of various options.

PRINCIPLE 5 APPLY BEST AVAILABLE KNOWLEDGE AND ADAPTIVE MANAGEMENT PROCESSES

ESFM would utilise the concept of adaptive management and continuous improvement based on best science and expert advice and targeted research on critical gaps in knowledge, monitoring or evaluation.

[1]Transparency in a process is the degree to which the public or stakeholder groups understand the decision-making process and can see who is taking decisions.
[2]Openness in a process is the degree to which it allows interested parties to participate in the decision-making process.
[3]Accountability in a process is the ability to identify who is responsible for implementing agreed decisions.

APPENDIX 2
Expert Review of Indicators

INTRODUCTION

This report has been prepared by FORTECH and CSIRO for the New South Wales National Parks and Wildlife Service as part of the process to develop criteria, indicators, targets and monitoring process for the Eden Regional Forest Agreement (RFA) region in south-east New South Wales.

Criteria and indicators provide a mechanism with which to assess changes in the extent or number of identified forest values. Monitoring changes in forest values against targets can help assess whether, or to what extent, forest management is "sustainable" with respect to those values. Criteria and indicators are therefore part of a dynamic process aimed at improving the sustainability of forest management.

Indicators developed in this report are intended to apply to all forests in the Eden RFA region, including private forests and public forests across all tenures. The proportion of public forests in each tenure category in the Eden RFA region is demonstrated by those for the Eden Native Forest Management Area (Table 2.1), which comprises most of the Eden RFA region.

TABLE A2.1
PUBLIC LAND, EDEN NATIVE FOREST MANAGEMENT AREA

Public land tenure category	Area (hectares)	Proportion (%)
National Park and Wilderness Areas	170 776	37
Nature, Flora & Fauna Reserves	35 520	8
Other Crown land	18 245	4
Pine plantations	32 000	7
State forest	202 030	44
Total	458 571	100

(Source: derived from State Forests of NSW Environmental Impact Statement)

The purposes of the report are:

- to explain the role of criteria and indicators in assessing ESFM;
- to explain international and national initiatives relevant to the development of criteria and indicators and other relevant policy commitments;
- to explain the processes in place to work towards ESFM in Australia;
- to develop a set of regional indicators that will enable ESFM to be assessed; and
- to provide a basis for consultation on further development of indicators for the Eden RFA region.

Points 1 to 3 are addressed in the following sections of the report. Experts in each field have been commissioned to draft reports on regional indicators, as required for point 4. These reports are in Annexures 1 to 7.

ROLE OF CRITERIA AND INDICATORS

The National Forest Policy Statement (1992) committed the State and Commonwealth Governments to ecologically sustainable management of forests. The New South Wales ESFM technical framework states:

> *"Ecologically sustainable forest management is managing forests so that they are sustained in perpetuity for the benefit of society by ensuring that the values of forests are not lost or degraded for current and future generations."*

The National Forest Policy Statement also set in train a process whereby the governments have been working together to assess the environmental, heritage, economic and social values of forests at a regional level. This comprehensive assessment process has provided for community input at a number of stages. It will enable governments to make long term decisions about forest areas to be set aside solely for nature conservation purposes and areas that may also be managed for timber production.

The intention of ESFM is accordingly to maintain or increase the full suite of values present in the forests, including the amount or level of those values. Values to be included at a national level have been agreed by the Commonwealth and State governments after consideration of the National Forest Policy Statement, Montreal Process, Forest Stewardship Council principles and criteria, other outcomes of the United Nations Conference on Environment and Development, the ISO 14000 Environmental Management System series and other matters. These values are outlined later in this report.

A system is required to enable the monitoring and measurement of ESFM values. Because many of the values are intrinsically difficult to define precisely and quantify, it is necessary to identify:

- *criteria* that define the values;
- *indicators* that enable the change in the amount or level of the value over time to be monitored; and
- *targets* against which management performance and progress can be assessed.

An indicator of ecologically sustainable forest management may be measured for comparison with a target in:

- quantitative terms, that is, numerically; and/or
- qualitative terms, that is, by describing its condition in words.

The usefulness and practicality of measuring an indicator will depend on a range of factors including its linkage to the criteria, its scientific basis, its ability to measure change and cost-effectiveness. These factors will be influenced by the extent and variability of the forested area to be assessed, the measurement frequency required, and the resources required for measurement, especially the human resources. These and other aspects concerning indicators for each criteria are discussed with respect to each criteria later in this report.

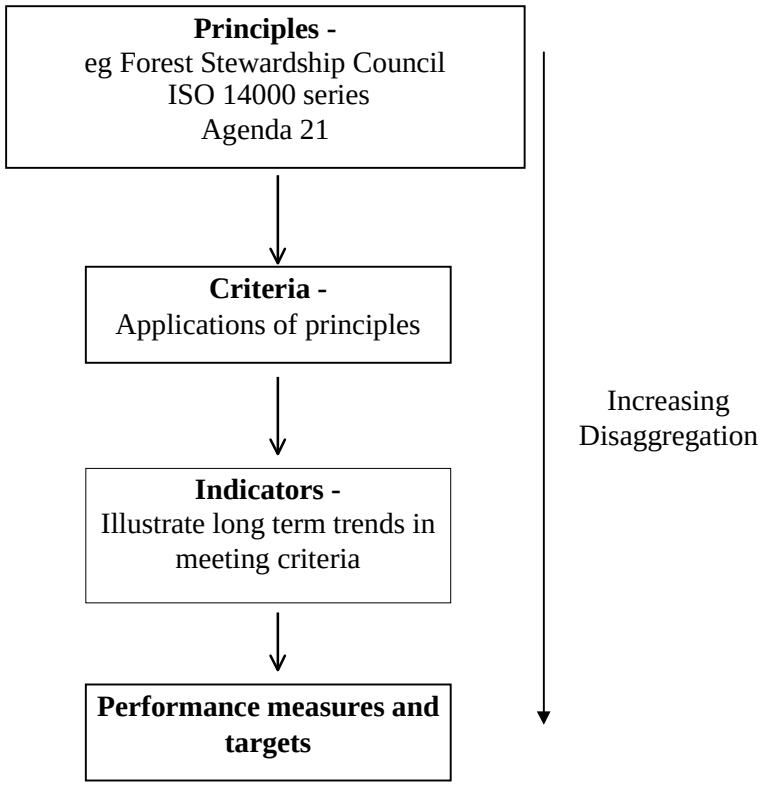
OTHER ESFM CONCEPTS

ESFM and the related forest certification and labelling of forest products are rapidly developing fields. They are the subject of considerable debate between governments, non government organisations, timber industry organisations and producers, community groups, forest owners and managers, and individuals around the world.

Forest certification involves independent verification that forests are managed in accordance with a set of agreed principles. Certification is usually linked to labelling forest products to provide consumers independent verification that the products are derived from sustainably managed forests. Both ESFM and forest certification depend on criteria and indicators.

The relationship between the various aspects of these concepts is show in Figure 1.1. The transition from principles, criteria, indicators and measures involves increasing levels of disaggregation in specifications of sustainable forest management. This usually also implies increasing geographical disaggregation.

Figure 1.1:
Concepts of Sustainable Forest Management



INTERNATIONAL INTIATIVES

There are several groups of initiative dealing with sustainable forest management and/or forest product certification in various stages of development:

- international initiatives resulting from the United Nations Conference on Environment and Development (UNCED);
- other multi-government initiatives and government aligned international groups, including the International Tropical Timber Organisation (ITTO) and the European Union Ecolabelling Scheme;
- national government led initiatives, such as in the Indonesia, Malaysia, Netherlands, New Zealand,
- initiatives promoted by non-governmental organisations (NGOs), such as the Forest Stewardship Council, Canadian Standards Association and the American Forest and Paper Federation; and
- environmental management systems, such as those developed by the International Standards Organisation (ISO).

The more significant of these initiatives are described in the following sections.

AGENDA 21

While interest in sustainable forest management can be traced back many years, activities became more focussed during the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992. That conference resulted in the adoption of a non-legally binding set of principles called Agenda 21. Chapter 11 of Agenda 21 dealt with forests.

Following UNCED, the United Nations established the Commission for Sustainable Development to oversee implementation of initiatives concerning sustainable forest management. The Intergovernmental Panel on Forests (IPF) was also established to progress forest issues related to UNCED. Of most significance for Australia, the IPF has been active in the "Montreal process" under which the countries with temperate and boreal forests are developing criteria and indicators. In parallel with the Montreal process there are the:

- Helsinki Process: developing criteria and indicators for European countries;

- Tarapoto Proposal: developing criteria and indicators for Amazonian States; and
- Dry zone Africa initiative: developing criteria and indicators for sub-Sahara dry zone African countries

The Montreal, Helsinki and Tarapoto initiatives are named after the location of the meeting at which agreement was made to proceed.

The International Tropical Timber Organisation (ITTO), which represents the governments of some of the countries that produce and consume tropical timber, is developing guidelines for sustainable management of their forests. This initiative precedes UNCED. ITTO prepared a guide to best forest management practices in 1989 and has since developed sustainable forest management criteria and indicators.

MONTREAL PROCESS

This process was initiated in 1993 by the Conference on Security and Cooperation in Europe at a conference in Montreal. A Working Group was established on criteria and indicators for the conservation and management of temperate and boreal forests (known as the Montreal Process). The group consists of Australia, Canada, Chile, Japan, Mexico, New Zealand, the Republic of Korea, the Russian Federation and the USA. Consensus recommendations on criteria and indicators for sustainable forest management for non-European temperate and boreal forests were agreed at a meeting at Santiago in February 1995 and announced in a statement that became known as the "Santiago Declaration".

The Santiago Declaration recognised the value of having an internationally accepted understanding of what constitutes sustainable forest management and the value of agreed criteria and indicators. However, the declaration also recognised that the application of criteria and indicators will need to take account of the wide difference among countries regarding the characteristics of their forests, including planted and other forests, land ownership, population, economic development, scientific and technological capacity and social and political structure. In other words, the criteria and indicators will require interpretation and adaptation before they can be applied at a regional level, such as to the Eden RFA region.

The declaration defined "criterion" and "indicator" as:

- *Criterion* A category of conditions or processes by which sustainable forest management may be assessed.
- *Indicator* A measure of an aspect of the criterion.

There are seven criteria, four of which concern the conservation of biodiversity and ecosystems processes. Each of the criteria contains a number of indicators of sustainable forest management (Table 2.2) that are discussed in detail later in this report.

TABLE A2.2:
MONTREAL PROCESS (SANTIAGO DECLARATION) CRITERIA AND INDICATORS

Montreal Process Criteria	Indicators
1. Conservation of biological diversity	9
2. Maintenance of productive capacity of forest ecosystems	5
3. Maintenance of forest ecosystem health and vitality	3
4. Conservation and maintenance of soil and water resources	8
5. Maintenance of forest contribution to global carbon cycles	3
6. Maintenance and enhancement of socio economic benefits	19
7. Legal, institutional and economic framework	5

Source: Canadian Forest Service, Quebec.

FOREST STEWARDSHIP COUNCIL

The Forest Stewardship Council was founded in Toronto, Canada, in October 1993. Council members include representatives of environmental institutions, timber retailers, forestry consultants, indigenous people's organisations, community forestry groups and forest product certification organisations. Members come from some 25 countries. It is constituted as an "*independent, non-profit, non-governmental membership organisation*" and is funded by a number of government and non-government organisations.

The primary functions of the Council are to:

- Develop and promote "principles and criteria for sustainable forest management";
- accredit organisations to undertake certification of forests.

The Councils principles and criteria are summarised in Table 2.3. These do not include indicators or performance standards.

The principles in Table 2.3 encompass the Montreal Process criteria but emphasise social aspects and processes for forest management. This emphasis reflects the origins of the Council in the debate over conservation of tropical forests and the effects of tropical forest logging on indigenous peoples.

Certification organisations have developed their own procedures for application of the Forest Stewardship Council's principles and criteria and have submitted these to the Council for accreditation. The first four certifiers to be accredited were:

- The "Smart Wood Program" developed by the Rainforest Alliance, a New York, USA, based environmental non-government organisation.
- The "Forest Conservation Program" developed by Scientific Certification Systems, an organisation based at Oakland, California, USA.
- The "Qualifor" Program developed by SGS Forestry, a company based in the United Kingdom.
- The "Responsible Forestry Programme" developed by The Soil Association, a non profit charity organisation based in the United Kingdom.

Due both to the broader range of issues addressed by the principles and criteria and also to the purpose being certification of forest products, the procedures are quite different to those required by the Montreal Process. The Soil Association's "Responsible Forestry Standards", for example, provide detailed guidance on the factors that should be considered at an operational level. These standards include the need for planning processes prior to timber harvesting to address environmental impacts, including conservation of biodiversity, that are addressed by the Montreal Process criteria. However, the standards also prescribe operational requirements concerning matters such as construction of roads and firebreaks, harvesting techniques, extraction of logs and establishment of plantations. These criteria are more equivalent to regulatory requirements included in Codes of Practice for forest operations in Australia. They do not provide the specific measurable indicators of sustainable forest management required by the Montreal Process.

TABLE A2.3
FOREST STEWARDSHIP COUNCIL PRINCIPLES AND CRITERIA

1. Compliance with laws and FSC principles applicable in the country
2. Tenure and use rights and responsibilities to land and forest resources
3. Indigenous peoples' rights to own use and manage land and resources
4. Community relations and workers' rights - social and economic well-being
5. Benefits from the forest - efficient use of multiple products and services
6. Environmental impact - conserve biological diversity, water resources, soils, ecosystems and landscapes
7. A management plan to be written, implemented and kept up to date
8. Monitoring and assessment shall be conducted to assess forest condition, product yields, social and environmental impacts
9. Maintenance of natural forests - primary and other forests to be conserved and not replaced by plantations or other land uses
10. Plantations - to be managed in accordance with principles 1 to 8

Source: Forest Certification Handbook, C Upton and S Bass, 1996.

NATIONAL FRAMEWORK FOR SUSTAINABLE FOREST MANAGEMENT IN AUSTRALIA

At the national level there is a complex array of arrangements in place which aim to achieve sustainable forest management in Australia. The *National Forest Policy Statement (NFPS)* provides an overarching commitment to sustainable forest management and it is a major theme throughout the document. It includes: establishment of a *comprehensive, adequate and representative (CAR)* forest reserve system; commitments to protect forest biodiversity, old growth and wilderness; promoting ecologically sustainable forest management which incorporates codes of practice, forest management planning, operational planning, and monitoring of impacts; and a set of nationally agreed principles of forest practices related to wood production to be applied to all public and private native forests.

The NFPS is complemented by a range of legislative and other processes at the State/Regional level. However, the major undertaking in respect of the NFPS at present is the completion of *Regional Forest Agreements (RFAs).* RFAs are the foundation on which future approaches to sustainable forest management will be based. A major aim of RFAs is to establish frameworks for ecologically sustainable management of forest resources on a regional basis in Australia. An important element in achieving this is the establishment of a CAR reserve system. The RFAs also aim to establish the basis for ensuring ecologically sustainable forest management practices are pursued and that there is a firm basis for ensuring future sustainable development of the forest industries as part of continued economic and social development.

The components of what constitutes ecologically sustainable forest management are evolving. The Ministerial Council on Forestry, Fisheries and Aquaculture (MCFFA) agreed on seven principles (and accompanying criteria) for assessing ESFM in Australia. The principles state that forest planning and management should maintain the suite of forest values for present and future generations and:

- protect and maintain biodiversity;
- maintain the productive capacity and sustainability of forest ecosystems;
- maintain forest ecosystem health and vitality;
- protect soil and water resources;
- maintain and enhance long term socio economic benefits;
- maintain the contribution of forests to global carbon cycles; and

- maintain natural and cultural heritage values.

These values are closely aligned with the criteria for sustainable forest management agreed under the Montreal Process. The key variations are that the Montreal Process criteria dealing with legal and institutional frameworks is not included and that natural and cultural heritage values are addressed specifically. Legal and institutional frameworks for forest management are comprehensively addressed for New South Wales, as will be explained later in this report.

A conference to discuss and achieve consensus on the above framework was held in November 1996. The conference agreed that, to be effective, regional indicators should (at least):

- be firmly linked to the criteria and be relevant to the region;
- have a sound scientific or other relevant basis;
- be understandable and clearly interpretable;
- be sensitive and powerful to critical change and include measures of error/confidence;
- have costs appropriate for their benefits;
- be feasible and realistic to measure over relevant time frames and spatial scales; and
- have targets or thresholds built in or be capable of having these applied.

The Annexures to this report assess the indicators for each criteria against the above specifications and their applicability in the Eden RFA Region.

APPLICATION OF CRITERIA AND INDICATORS IN AUSTRALIA

Australian governments have established the Montreal Process Implementation Group (MIG) to attend to Australia's responsibilities under the Montreal Process. These responsibilities include to:

- prepare a report, referred to as the "first approximation report", explaining how the criteria and indicators can be applied on a nation wide level;
- Interpret and develop regional applications of the Montreal Process criteria and indicators.

Developing the first approximation report, which was published in June 1997, served to test whether the data necessary to assess criteria and indicators was available, at least at a national level. The report found that, at a national level, further work is needed to establish the connection between some of indicators and sustainability and to establish a baseline against which trends in some indicators can be assessed.

The Forest and Wood Products Research and Development Corporation has commissioned research into aspects of applying Montreal Process criteria and indicators:

- commercial forests, that is, plantations;
- montane forests; and
- NSW Alpine Ash forest.

Table 2.4 outlines the major conclusions of these studies. The studies also concluded that development of quantitative performance measures for each indicator requires resources, credibility and research and highlighted the fact that application of the criteria will not be consistent across the continent because of the heterogenous nature of the forest resource.

TABLE A2.4
APPLICATION OF MONTREAL PROCESS CRITERIA AND INDICATORS IN AUSTRALIA

Native Forests	Plantations
The criteria and indicators of the Montreal Process must be applied at a local management area level, even though initial consideration internationally is at the country level.	

Species diversity within native forests can be researched and established scientifically.	Species diversity in plantations is subjective and standards may change depending on plantation definitions.
The development of measurement systems for indicators requires research, resources and credibility. Due to the diversity of Australian forests and plantations, the development of these measurement systems is recommended to be incremental.	
Criteria 6 (socio-economic benefits) and 7 (legal, institutional and economic frameworks) will require a significant amount of consideration for application in the Australian context. The degree of work required will be equally as hard for native forests as plantations.	
Assessment standards for native forests will be reasonably consistent within the definitions of what constitutes a forest.	Assessment standards for plantations will be subjective and changeable depending on whether plantations are considered to be forests or crops. This dilemma may be detrimental to the acceptance of certification of plantations by some groups.

OTHER REGIONAL FOREST AGREEMENT REGIONS

As well for the Eden FRA region, the regional forest agreement process is also well advanced for Tasmania and East Gippsland. Lessons learned there may have a bearing on the process for the Eden RFA region.

A report prepared as part of the regional forest agreement process for East Gippsland, which adjoins the Eden RFA region, included an assessment of the availability of the information required to evaluate each indicator. The conclusions of that assessment are summarised in Table 2.5 The numbers of indicators for which the data available was limited or inadequate or for which only an approximation was available is only around half of the total number of indicators and considerably less than half for some criteria. This is all the more significant when it is considered that the forests of East Gippsland have been the subject of many investigations and many years of extensive and intensive survey, assessment and research.

The final report on the Assessment of Ecologically Sustainable Forest Management Systems and Processes for the Tasmania-Commonwealth Regional Forest Agreement (Background Report Part G, February 1997) also analysed assessing ESFM against principles and criteria. While that report does not develop measurable indicators, it describes many legislative, regulatory or other processes that address many of the principles and criteria. However, it is clear that there are conceptual differences and/or deficiencies and gaps in these processes, and inadequate data and/or understanding of natural processes to enable assessment of sustainability for all criteria. Further work was recommended in areas addressed by most principles and criteria.

In conclusion, forests in East Gippsland and Tasmania have been subject to land use studies and research over many years. Despite those studies and research, it was found that further work was deemed necessary to enable assessment of all criteria for these areas. This suggests assessing many of the Montreal Process indicators will also present challenges for the Eden RFA region.

TABLE A2.5
ASSESSMENT OF INDICATORS FOR EAST GIPPSLAND, VICTORIA

	Number of indicators for which:			
Criterion (number of indicators)	Adequate data available	Limited data or approximation	Inadequate data	Indicator not applicable
1. Biological diversity (9)	6	2	1	
2. Productive capacity (5)	3	1	1	
3. Ecosystem health (3)		2	1	
4. Soil and water resources (8)	1		7	
5. Global carbon cycle (3)			3	
6. Social and economic (19)	7	3	6	3
7. Legal, etc, framework (10)	10			
Totals (57)	**27**	**8**	**19**	**3**

NEW SOUTH WALES

Arrangements for planning and implementation of management of public forests is the responsibility of State Governments. These arrangements are being examined in the RFAs as part of the ESFM assessments. The States have detailed administrative and legal arrangements in place related to planning for timber production from State forests. Table 2.6 lists legislation relevant to ESFM in NSW.

Legislation at all levels is backed up by regulations that specify the arrangements for implementing policies from the state level down to individual management units. By way of illustration, the following provides a brief outline of a typical set of requirements for approval of operations in public native forests in NSW:

- Areas consistent with agreements under the State Interim Assessment Process/Comprehensive Regional Assessment options/decisions;
- EIS completed - provides general environmental analysis and approval for operations on a regional basis;
- forest management plan completed - addresses achievement of sustained yield;
- harvest plan prepared - enables scheduling of operations and application of code of practice;
- external approvals obtained - environmental approvals required from a number of State and Commonwealth agencies;
- harvest supervision - supervision of harvesting operations to ensure compliance with codes and management plans;
- monitoring and reporting - as part of normal accountability arrangements, State Forests need to report against a wide variety of criteria; and
- audits - State Forests has in place a comprehensive internal audit process which includes examination of compliance with internal and external controls.

TABLE A2.6
KEY STATE LEGISLATION RELEVANT TO ESFM IN NSW

Legislation	Nature of Requirement/Provision
Catchment Management Act 1989	Catchment protection, management and planning
Clean Water Act 1970	Water pollution control
Coastal Protection Act 1979	Protection of coastal areas
Environmental Planning and Assessment Act 1979	Environmental planning instruments, control and assessment
Forestry Act 1916	Dedication and management of flora reserves State forests
Heritage Act 1977	Protection of environmental heritage
Mining Act 1992	Mineral claims and exploration
National Parks and Wildlife Act 1974	Dedication and management of national parks
Pollution Control Act 1970	Licences for potentially polluting activities
Protection of the Environment Administration Act 1991	Environmental performance targets for pubic authorities
Rivers and Foreshores Improvement Act 1948	Protection of riverine environment
SEPP 46 Protection of Native Vegetation	Control of native vegetation clearance
Soil Conservation Act 1938	Prevention of soil erosion or land degradation
Threatened Species Conservation Act 1995	Protection and recovery of flora and fauna
Timber Industry (Interim Protection) Act 1992	Protection of certain timber areas pending EISs
Timber Plantation (Harvest Guarantee) Act 1995	Timber plantations harvesting code
Wilderness Act 1987	Protection and management of wilderness areas

ENVIRONMENTAL MANAGEMENT SYSTEMS

The International Standards Organisation (ISO) is a worldwide federation of national standards bodies from some 90 countries. Its purpose is to develop and promote standards worldwide to assure consistency in approach to matters affecting scientific, technological and economic activities, including trade. It uses a consultative process to develop standards to facilitate widespread acceptance and support for the standard.

ISO's standard "ISO 9000" provides a standard approach to managing *quality* objectives in an organisation. British Standard BS 7750 applied the ISO 9000 approach to environmental quality objectives. Following international interest in BS 7750, the International Standards Organisation commenced development of ISO 14001, the first of a series of environmental management standards for international application. The series addresses principles, systems, supporting techniques and procedures for environmental management systems and environmental auditing.

The principles within BS 7750 and ISO 14001 include that an organisation should:

- establish and maintain an environmental management system with a defined and documented policy;
- define and document staff responsibilities, authority and interrelations;
- provide for verification of resources;
- provide communication procedures and training;
- identify, examine and evaluate environmental impacts;

- maintain a record of legislative, regulatory and policy requirements; and
- specify environmental objectives and consequent targets and have a program to achieve these.

These principles are focussed on management of a commercial organisation. There are some similarities with the Forest Stewardship Council principles, at least in reference to legislative and regulatory requirements (FSC Principle 1), attention to environmental impacts (FSC Principle 6) and monitoring and assessment (FSC Principle 8). However, the Forest Stewardship Council's Principles go beyond ISO 14001 in the areas of socio-economic concerns and land use policy.

Having identified, examined and evaluated the environmental impacts of an organisation's activities, ISO 14000 requires the establishment of indicators and targets. The indicators are then used in the environmental management system to assess performance and, in particular, to assist progress towards targets. The environmental management system approach is therefore consistent with the Montreal Process.

OTHER INTERNATIONAL POLICY COMMITMENTS

As well as the Montreal Process, Australia is committed to a number of other international processes and commitments that impact on the achievement of sustainable forest management in Australia. Those particularly relevant include:

- *United Nations Convention on Biological Diversity*. Australia is a signatory to this convention which calls for setting aside of forest reserves and for sustainable forest management as part of its mandate to preserve biodiversity. As part of fulfilling these commitments Australia has developed a National Strategy for the Conservation of Australia's Biological Diversity.
- *United Nations Framework Convention on Climate Change*. As part of fulfilling its commitments under this convention Australia has developed a National Greenhouse Response Strategy. In respect of forests, the national strategy has objectives of conserving and enhancing the sink capacity of Australia's environment, and minimising greenhouse gas emissions from the natural environment caused by human activities.
- *Convention on International Trade in Endangered Species of Flora and Fauna (CITES)*. This convention to which Australia is a signatory can restrict trade in forest products derived from endangered plant species. Australia's endangered species and export control legislation are consistent with its commitments under CITES.

APPENDIX 3
Expert Identified Indicators of Sustainable Management for Biodiversity in the Eden Forests

BACKGROUND ISSUES

Preamble

Maintenance of biodiversity leads to more debate than most other criteria of ecological sustainability. This is partly due to different interpretations of the word "biodiversity", but is also due to the variety of expectations about what a set of biodiversity indicators can and should deliver. Our discussions with stakeholders in the Eden region indicate a wide range of views about the number and scope of indicators that is desirable in this region, about the degree to which indicators can be expected to "diagnose" sustainability versus give confidence that adequate levels of precaution are being applied, and about how the regional-scale indicators developed in this project should relate to performance indicators developed at other levels in the forest management process in the region. In the context of the Regional Forest Agreement process, these different expectations and viewpoints are as important as the scientific issues relating to long term viability of forest ecosystems, and we have tried to take this into account in our deliberations. In the following sections we address these issues briefly and describe the approach we have taken.

Biodiversity

Biodiversity is the variety of all life forms; the different plants, animals and micro-organisms, the genes they contain and the ecosystems which they form by interaction with one another (Saunders et al., in review). In its report on the state of the environment, the State of the Environment Advisory Council (Australia) (1996) noted that the conservation and maintenance of biodiversity is important for at least four reasons.

- Biodiversity provides the critical ecosystem processes which make life possible and are often taken for granted. Healthy functioning ecosystems are necessary to maintain and regulate climate, fresh water, soil formation, the cycling of nutrients and waste disposal.
- Maintaining biodiversity is an ethical imperative. No single species and no generation has the right to sequester the biological resources of the earth solely for its own benefit.
- There are aesthetic and cultural reasons for maintaining biodiversity. Many Australians place a high value on indigenous plants, animals and ecosystems, which contribute to a sense of cultural identity, spiritual enrichment and recreational opportunities. Biodiversity is a central component of the cultures of Aboriginals and Torres Strait Islanders.
- Components of biodiversity have significant economic values. They control pest plants, animals and diseases, pollinate crops and provide food, clothing, building materials, medicines and many kinds of raw materials, and form the basis of a substantial tourist industry.

Biological systems are organised hierarchically from the molecular to the ecosystem level. Logical classes such as genotypes, populations, species, communities and ecosystems are heterogeneous, which means that all members can be distinguished from one another. The variety of biological configurations at all levels is extremely large, currently unknown and probably unmeasurable. Yet for monitoring of, and reporting on the condition of, biodiversity, there has to be some acceptable classification and baseline against which change can be measured.

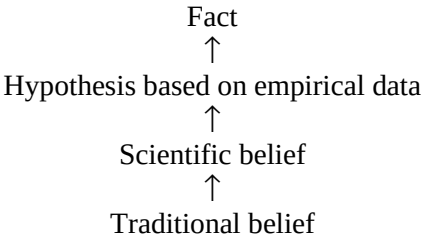
For this report we have adopted partial measures of biodiversity, which we call surrogates, which reflect current levels of knowledge and take into account the need for them to be measurable and interpretable. These are forest types (as used for the CAR reserve process), environmental variables such as soils, topographic position and aspect, habitat structure, understorey floristics, forest age class, fire history, threatened, rare, endangered and vulnerable species.

The Present State of Scientific Knowledge

It is not the role of this report to analyse in detail the current state of scientific knowledge with respect to biodiversity issues. However, the state of knowledge is an important consideration in drawing our

conclusions and will be referred to briefly where appropriate. In relation to the hierarchy of scientific knowledge depicted in Figure 1, our knowledge about what determines sustainability of biodiversity and how the determinants can be measured is at the stage of scientific belief or hypothesis based on very limited empirical data. The implication, therefore, is that interpretation of most, if not all, indicators should be subject to ongoing research and the indicators themselves will have to change as our understanding improves.

Figure 1:
Depiction of the hierarchy of scientific knowledge starting with belief and hypothesis and leading, eventually, to fact (from an idea by Daniel Botkin).



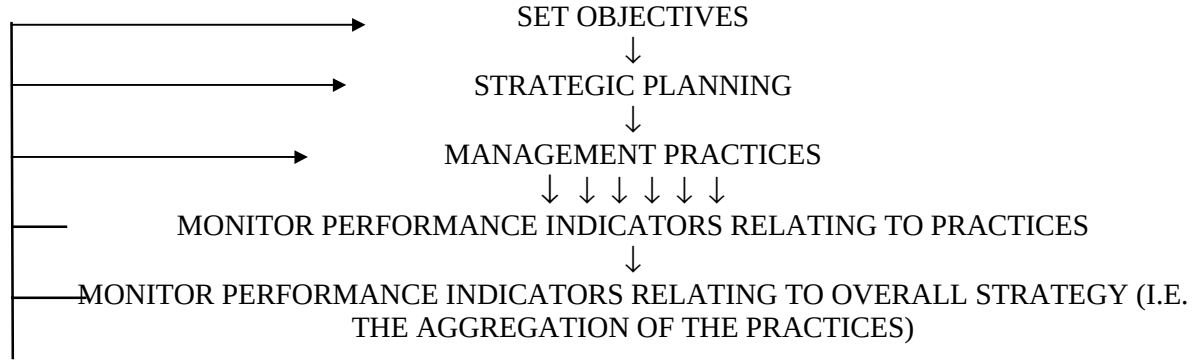
The Role of Regional Biodiversity Indicators in the Context of the Eden Regional Forest Agreement Process

For effective achievement of ecologically sustainable forest management, the objectives of the management must be agreed upon, management strategies developed and practices set in place, performance indicators determined by which the success of practices and the overall strategy can be gauged, and a mechanism put in place by which lessons learned can be used to improve strategies and practices. Within this scheme there are many layers of performance criteria and indicators. We cannot hope to provide indicators and targets at all of these levels; the time and budget do not allow it and the range of expertise and experience needed would require the involvement of a much larger group of people than can be brought together in the few weeks allowed for this consultancy. Therefore, we have to define the scope of the criteria and indicators we are to prepare and where we are to stop.

Both the brief we have been given and the Comprehensive Regional Assessment/ Regional Forest Agreement process to date have provided only very broad guidelines for what these indicators are to achieve. The emphasis is on assessing whether Ecologically Sustainable Forest Management is being achieved at the regional level and on providing early warning of possible problems. There are few precedents in the international literature on biodiversity indicators for forests as this literature is dominated by the Montreal process which focuses on reporting at the National scale and only recently has begun addressing application at the regional scale. More recently, the State of the Environment reporting process also has addressed the issue of reporting at National scales within Australia, although it considered a large number of indicators that could be applicable at regional scales.

We have been asked to consider the Montreal criteria and indicators as a starting point, since it is desirable that indicators used at the Regional Forest Agreement scale are consistent with those used at the National scale. To further define the scope and scale of our recommendations, we propose the following distinction (Figure 2) between indicators of the performance of the individual practices that in aggregation are expected to deliver Ecologically Sustainable Forest Management, and indicators that assess whether that aggregation of practices is being successful in delivering Ecologically Sustainable Forest Management.

Figure 2:
Depiction of the different levels of indicators in a integrated environmental management system



We interpret our purpose as recommending indicators and targets at the level of the overall strategy rather than at the level of individual practices. Specification of indicators and targets for management practices should be dealt with as part of the development of operational plans. For example, specification of the number of habitat trees to be retained after harvesting, the widths of buffer strips along streams, or special practices to be employed in relation to particular species should all be determined with the best scientific input from the leading experts in each field. Auditing processes should be put in place to assess whether these prescriptions are implemented and persist as expected. As part of the development of management prescriptions relating to biodiversity, there should be explicit statement of the assumptions made about how the management will affect target species and biodiversity overall and clear indicators and targets should be defined that will allow assessment of whether the management prescriptions are achieving their predicted outcomes. The associated "response to disturbance" project as part of the Eden Comprehensive Regional Assessment is employing a wide range of experts and should provide much of the information on which species are of concern and what targets are appropriate for retention or restoration of habitat and for achieving viable population levels. We see it as our role to recommend indicators that relate to whether or not the recommendations of these experts are being incorporated into implementation plans and whether the necessary monitoring is under way to assess both whether the targets are being achieved and whether they were appropriate in the first place.

OUR APPROACH

One desirable approach to our task would have been to convene workshops of a wide range of experts on biodiversity to review the literature on biodiversity indicators, assemble a comprehensive list of potential indicators and rank this list in relation to the criteria for useful indicators listed in our brief (see below) and the considerations discussed below. The criteria for a useful indicator listed in our brief are that the indicator must:

- have a sound scientific basis;
- be clearly understandable and interpretable;
- have costs appropriate to benefits;
- be feasible and realistic to measure;
- have targets and thresholds built in;
- contribute directly to continuous improvement of management;
- be sufficient when taken together to assess whether Ecologically Sustainable Forest Management is being achieved.

We suggest that another should be added:

- provide early warning of potential problems

Time and budget have not allowed us to follow the path outlined above. Therefore we have drawn extensively on two processes that have brought experts together recently for very similar tasks. Firstly, the Commonwealth Government recently commissioned a report on indicators for State of the Environment

reporting on biodiversity in Australia. Two of our team were senior authors of that report, which was submitted earlier this year. Preparation of the report engaged a large number of experts in workshops and a detailed review of the literature. While the report concentrated on indicators at a national scale, it considered and documented a range of indicators relevant at regional and finer scales. Secondly, the Montreal Implementation Group has recently run a workshop of experts to discuss application of the Montreal Criteria and Indicators at the regional scale in Australian forests. This workshop was attended by two of our team and we have drawn on the synopsis of that workshop. Both of these reports are currently at a draft stage and we have not been given permission as yet to use them as input to our report. We anticipate little difficulty in getting permission to use these reports once finalised and will be seeking that permission before submitting our final report.

We recognise that perceptions and concerns of the public are at least as important as scientifically determined issues when developing indicators that will give all stakeholders confidence that achievement of Ecologically Sustainable Forest Management is being monitored adequately. Accordingly, we have attended two meetings of the Eden Regional Forest Forum and have requested and received written inputs from members of the forum.

We have summarised the information and opinions gathered in these ways in the appendices at the end of this report. We have dealt with the information in four main ways. Firstly, we have generated our own ideas about what would constitute an adequate set of indicators for biodiversity and have assessed these ideas against those coming from the State of the Environment, Montreal Process and Regional Forest Forum reports. Secondly, we have gone through the lists of possible indicators put forward in the various reports and assessed each against both the criteria for useful indicators (see above) and whether they were at an appropriate level with respect to the discussion in Section 0. Thirdly, we have cross-checked to make sure that all concerns expressed by stakeholders have been addressed in some way within the set of indicators recommended. Finally, we are circulating drafts of this report for comment among as many stakeholders and relevant experts as time would allow.

RECOMMENDED KEY INDICATORS

Explanation

According to most definitions, biodiversity includes not just genes, characters and species, but also the variety of environments and habitats that allow species, populations and assemblages to co-exist and encourage speciation. Assessing whether forest management is sustaining biodiversity in the Eden forests requires monitoring at all of these levels. But, because scientific knowledge about assessing biodiversity and its sustainability is limited, it is not only important to assess the outcomes of management but also the institutional processes that assess the adequacy of data input to management, ensure that inadequacies are taken into account in risk management procedures, and facilitate ongoing collection of the right data and input of the best available scientific expertise to improvement of practices.

These multiple levels of biodiversity assessment and the distinction between indicators of outcomes and institutional processes are acknowledged by the Montreal Criteria 1 and 7. We recommend indicators of both outcomes and processes below (Section 0). It is not clear to what extent indicators of institutional processes will be dealt with by Ecologically Sustainable Forest Management Project 6, but because of their importance for both achieving Ecologically Sustainable Forest Management and allaying many concerns expressed by stakeholders, we have included them here.

It is important to note that although biodiversity is most precisely measured in terms of genes, individuals and species, methods and knowledge for doing this comprehensively are generally poor. Accordingly, many of our recommended indicators at this level are either in need of further research and development or concentrate on only a small part of biodiversity; the species of plants and (mostly vertebrate) animals thought to be most at risk. We suggest additional measurements to expand the diversity of species measured but it is unrealistic to expect that a simple measure of overall biodiversity will be possible in the near future. On the other hand, measurement of the variety of broad assemblages of species and habitats for flora and fauna is more tractable and includes a wide variety of ecosystem processes expected to be related to biodiversity. While we recognise that use of vegetation assemblages as surrogates for biodiversity is questionable on its own, we recommend that these coupled with assessments of habitat structure and composition and ecosystem function (an indicator for which is proposed under Ecosystem Health and Vitality) offer the most practical

and cost effective way to assess the condition of ecosystems and the potential for biodiversity to be sustained.

Finally, we stress that these recommendations have been developed over a very short time frame dictated by the timelines of the Eden Regional Forest Agreement process. Therefore, while we have tried to minimise the number of indicators we have not had time to refine them as much as might be desirable. Although there still are a large number, many are easily monitored from information already available or likely to be available.

Recommended Indicators

1. Extent of forested area by forest type

Description:

The areal extent of forest types relative to total forest area. This includes, by default, the number and identities of forest types. These forest types should be the same ones used for the CAR process in the Eden region.

Rationale:

Forest type is a measurable and mappable expression of biological diversity. Different types reflect different ecological and environmental conditions and are, therefore, expected to reflect differences in components of biodiversity in addition to the plant species used to derive the forest types. This indicator will show the extent to which forest cover within each forest type is increasing, decreasing or staying the same.

Analysis and interpretation (including targets):

The number and identity of forest types and maps and tables to monitor changes in forest cover and measure gains and losses in extent by forest type. The immediate target should be no net loss from any forest type but later targets, especially as knowledge improves, might relate to allowable losses or desired increases decided by negotiation among stakeholders.

Monitoring design and strategy:

Forest types should be listed and mapped and maps should be digitised and held in a geographic information system. The baseline should be pre 1750 extent, which has been estimated for this region. Monitoring by forest type is still problematic. Total forest area can be monitored by satellite remote sensing but forest type mapping will have to be done from aerial photographs and ground survey. New research is required if forest types are to be mapped and monitored with satellite imagery.

Outputs:
Maps and tables showing the extent of change. The reporting period should be five years.

Data requirements:
Area of each forest type by tenure and estimates of pre 1750 extent.

Links to Montreal indicators:
Encompasses Montreal 1.1a.

2. Representation and extent of forest types, and the biotic and abiotic variation within them, within protected areas

Description:
The area of each forest type included within protected areas as a percentage of the pre 1750 area, and the biotic and abiotic variation included within that area. Protected area definitions should fall within IUCN categories.

Rationale:
Protected areas are a necessary component of any strategy for sustaining forest biodiversity, but are not alone sufficient. The goal of a protected area network is to represent, comprehensively and adequately, the biological diversity of the region that network is situated in. This indicator measures the degree to which that goal is achieved.

Analysis and interpretation (including targets)

There are nationally agreed criteria for a comprehensive, adequate and representative (CAR) reserve system, which are being implemented in the Eden region. A target of 15% of each forest type (with some flexibility depending on local situations) has been agreed (Commonwealth of Australia, 1997). It has also been agreed that, as far as possible, the reserve system should sample the full range of biological variation (ie. diversity) within each forest type(Commonwealth of Australia, 1997). Biological diversity is expected to vary systematically with environmental variables (eg. soil type, aspect and topographic position), and with understorey floristics, habitat structure, forest age class and fire history, all of which can be expected to change over time. It is unlikely that 15% will always be sufficient to cover such a range of variation within forest types.

Monitoring design and strategy:
The CAR reserve system should be monitored to determine its continuing comprehensiveness, adequacy and representativeness over time. Monitoring should aim to assess the full range of variation in environmental variables, understorey floristics, habitat structure, forest age class and fire history within each forest type within the region and the extent to which these variables are represented in the CAR reserve system. To do this comprehensively would require monitoring to be stratified by environmental variables, fire history and management practices or other mappable disturbances that could affect forest structure or understorey floristics. Costs would be prohibitive if all combinations of all strata were to be monitored in all protected areas, so a representative sub-set would have to be chosen. It is not immediately obvious what this sub-set would be, but designing a suitable monitoring program is a problem amenable to solution with a collaborative research project between scientists and managers. It is important that, in finding a cost-effective design, replication and statistical power (ie. ability to detect a response if one occurs) are not sacrificed. This might mean fewer forest types or fewer variables are sampled but this is preferable to broad sampling with inadequate replication, which could fail to yield unequivocal conclusions.

Outputs:
Maps, tables and reports tracking changes over time.

Data requirements:
Maps of relevant environmental variables, understorey floristic communities, habitat structure, forest age classes and fire history. Some survey effort may be needed to enable mapping of understorey floristics, but a comprehensive data set on understorey floristics has been collected and analysed by NSWNPWS. Surveys have been done for age classes; classification differs for different forest types. Methods are available to assess habitat structural complexity from the ground and are developed and ready for testing with respect to remote sensing of habitat complexity.

Links to Montreal indicators:
Encompasses Montreal 1.1c and 1.1d

3. Maintenance of biodiversity within forest types outside protected areas

Description:
The extent to which the variation within forest types continues to be represented regardless of tenure.

Rationale:
It is unlikely that reserves alone can encompass, let alone sustain, the biological diversity of different forest types. It is therefore necessary to monitor biodiversity proxies outside reserves in the same way as they are monitored within reserves in indicator 1.3 above, to track their fate throughout forest types.

Analysis and interpretation (including targets):
Analysis and interpretation should show whether or not biodiversity surrogates are being sustained in managed forests. For example, each forest type should be represented by the range of age classes from regrowth to old growth in order to ensure that management practices allow older growth age classes, with their different associated biological diversity, to develop in each forest type. Similarly, understorey floristic composition should be maintained such that there is no loss of species due to management practices over a full rotation. Different forest types will have different targets depending on the species living in them. Targets relating to the relative amounts of different growth stages, understorey floristic communities and habitat complexity should come from the Fauna Modelling project (ie. as part of descriptions of habitat requirements for fauna and flora) and the Response to Disturbance project (ie. as recommendations for amounts and configurations of habitat for key species). Further input to targets on proportions and configurations of growth stages should come from the Scenario Modeling project as only a modeling approach can hope to tell us what targets will lead to ongoing recruitment into older age classes.

Monitoring design and strategy:
The monitoring design should be the same as that for indicator 1.2 above. The monitoring design should especially focus on management practice as an experimental variable so the null hypothesis that a given management practice does not reduce biodiversity can be tested with the results of the monitoring program. As in 1.2 above, the cost of such a program could become prohibitive, but again, an appropriate cost-effective design could be determined in a collaborative research project. As with Indicator 1.2, it is important that replication and statistical power are not sacrificed in finding a cost-effective design.

Outputs:
Maps, tables and reports on trends in the chosen biodiversity proxies.

Data requirements:
Maps of relevant environmental variables, understorey floristic communities, habitat structure, forest age classes and fire history. Some survey effort may be needed to enable mapping of understorey floristics, but a data set on understorey floristics has been collected and analysed by NSWNPWS and this could be assessed for any variables not adequately sampled and the gaps filled. Surveys have been done for age classes; classification differs for different forest types. Methods are available to assess habitat structural complexity from the ground and are developed and ready for testing with respect to remote sensing of habitat complexity.

Links to Montreal indicators:
Expands on Montreal 1.1b

4. Degree of fragmentation within each forest type and across the overall forest estate

Description:
The extent to which forests and forest types are fragmented by clearing, reduction of structural or floristic complexity, or other major disturbance activities.

Rationale:
Fragmentation of forests disrupts ecological processes such as nutrient and energy cycling, creates sub-populations of species and isolates those sub-populations from one another reducing the size of the gene pool. Average population size is smaller and population variability increases, increasing the risk of local extinction due to unpredictable environmental and/or demographic fluctuations. Repeated local extinctions lead to global extinction.

Analysis and interpretation (including targets):
Analysis requires mapping of existing habitat remnants, measuring the degree of fragmentation and monitoring changes. The target is minimum degree of fragmentation suitable to maintain all species in the region. Fragmentation indices incorporating patch size, distance between patches, connectivity and area to perimeter ratios are required for measurement. The scale of measurement will effect the interpretation of such indices, especially the consequences of isolation for species and genetic diversity and this needs further investigation. Many such indices have been proposed and measurement could proceed in the near future. However, interpretation of these measurements in terms of viability of biodiversity is at a preliminary stage and could be done for very few species. Ongoing research is needed to relate measures of landscape configuration to indices of biodiversity.

Monitoring design and strategy:
Existing forest remnants should be mapped and the degree of fragmentation calculated. Fragmentation indices need to be developed for this purpose. DPIE is currently investigating a range of possible indices and this work should continue to be supported. Remote sensing with satellite imagery can produce maps of existing woody vegetation, cleared areas and revegetated areas. Existing GIS software could be used to store maps of vegetation remnants, measure sizes and make other calculations for fragmentation indices once they are developed. However, to do this by forest type will require new research on the relationship between remotely sensed images and forest types.

Outputs:
Maps and tables showing trends in fragmentation.

Data requirements:
Maps, remote sensing imagery, fragmentation indices and estimates of dispersal rates and mechanisms and gene flow among forest dwelling species.

Links to Montreal indicators:
Encompasses Montreal 1.1e.

5. The number and identity of known forest dwelling species within each forest type

Description:
The list of forest dwelling species in the region, from which total number can also be extracted.

Rationale:
A goal of ESFM is to conserve all forest dwelling species throughout their natural ranges. In order to do this, a list of species has to be maintained and reviewed and updated periodically.

Analysis and interpretation (including targets):
Additions and deletions to the list should be interpreted carefully. Disturbances can lead to the introduction of new species, but if they are weeds then they do not constitute an increase in forest biodiversity. Similarly, losses of species from the list may be due to changes in knowledge or natural fluctuations in local abundance and these do not necessarily represent a loss of forest biodiversity.

Monitoring design and strategy:
Lists of species should be compiled from museums and herbariums, management agencies such as NPWS and State Forests, and new surveys to fill gaps in coverage. Geographic locations of field records should also be kept so that the data can be used, for example, to improve forest classifications and contribute to the interpretation of monitoring studies.

Outputs:
- The total number of species and changes in that total over time, with notes on interpretation, including presumed reasons for any changes.
- Lists of species, by forest type, and changes in those lists over time, with notes on interpretation, including presumed reasons for any changes.

Data requirements:
The name of the species and the geographic location it was recorded from.

Links to Montreal indicators:
Builds on Montreal 1.2a

6. The number and identity of forest dwelling species considered to be at risk of not maintaining viable populations as determined by legislation or scientific assessment, classified by status (threatened, rare, vulnerable, endangered, extinct)

Description:
The list, and therefore the number, of threatened, rare, vulnerable, endangered and extinct species.

Rationale:
It is a goal of ESFM that forests be managed so that no species suffers a deterioration of its risk status and, where possible, to improve that status.

Analysis and interpretation (including targets):
An explicit system of classification that utilises expert knowledge and takes account of the nature of that knowledge and the uncertainty associated with different types of knowledge is needed for proper interpretation. This is necessary so that classifications are comparable from period to period. This is a fairly insensitive indicator as by the time classifications are changed populations can be declining rapidly.

Monitoring design and strategy:
Lists of species, by classification, should be compiled, and reviewed and updated periodically. The number of listed species for which recovery plans exist should also be monitored as this is an indicator of what is being done to address the problem.

Outputs:
The list, and therefore the number, of species in each category and changes over time.

Data requirements:
National and State lists of species in each category including estimates of range and abundance and whether or not recovery plans are being implemented. These lists should be supplemented by local knowledge and the results of local studies so that an accurate regional list is maintained.

Links to Montreal indicators:
Expands on Montreal 1.2b

7. Population viability parameters for species of concern

Description:
Population sizes and habitat requirements of threatened, rare, vulnerable and endangered species.

Rationale:
All species identified as under threat should have conservation or recovery plans formulated and implemented. These should provide targets for population size and amount and configuration of habitat and these targets should be monitored as part of the implementation of those plans. Lists of these species and targets will be generated by the "Response to Disturbance" project as part of the Eden Comprehensive Regional Assessment

Analysis and interpretation (including targets):
Targets for population size and habitat requirements will have to be set for each species separately, requiring knowledge of the individual species' requirements. Expert knowledge should be used to do this.

Monitoring design and strategy:
Population parameters for these species should be monitored at a level adequate to assess whether set targets are being achieved and, therefore, whether populations are remaining stable, decreasing or increasing.

An alternative indicator might be the proportion of species for which plans are developed and implemented.

Local volunteer groups could play a valuable role in monitoring population size and distribution patterns of some of these species and they should be utilised where appropriate.

Outputs:
Periodic reports on population size and distribution patterns, including projected trends.

Data requirements:
Monitoring population viability requires data on population size, distribution and demography, all of which can be time consuming and expensive to collect. The field data then have to be analysed and trends have to be modelled.

Links to Montreal indicators:
Goes beyond Montreal 1.2b; necessary to be relevant at regional scale

8. Population levels, range and reproductive status of selected species from diverse habitats monitored across their range

Description:
Trends in population size, range and reproductive status of a representative sub-set of taxa not already included as biodiversity surrogates.

Rationale:
Biodiversity is much more than the surrogates used in indicators 1.2 and 1.3 above, which were chosen for ease of measurement and mapping (and therefore monitoring). This indicator is designed to detect trends in some of the other components of biodiversity. As a bonus, the data could be used in two other ways. First to test whether or not the chosen proxies really do indicate trends in more of biodiversity and second to detect more subtle changes resulting from management practices, which could, in turn, form the basis for an adaptive management program.

Analysis and interpretation (including targets):
Changes in population parameters, ranges and reproductive status of components of biodiversity other than the chosen proxies will have to be interpreted in the light of management practices, fire regimes and natural fluctuations. If natural fluctuations can be controlled for, then the monitoring program can be viewed as an experiment, the results of which can be fed back into management so that management practices respond in an adaptive way to the generation of new knowledge. The target for each species would be to maintain population parameters within acceptable limits determined by analysis of data from control populations (ie. not subject to human management).

Monitoring design and strategy:
Using the monitoring design derived for indicators 1.2 and 1.3 above, record population sizes, location and reproductive status of a set of taxa chosen to represent the different kinds of biota present. This set should include fungi, terrestrial and arboreal invertebrates and micro-organisms. Sampling strategy and periodicity should be determined in collaboration between managers and researchers, who would both then be responsible for analysing and interpreting the results.

Outputs:
- Reports on trends in components of biodiversity other than the chosen proxies.
- Tests of the chosen biodiversity proxies.
- New knowledge on the responses of biodiversity to management practices and the opportunity for adaptive management

Data requirements:
A sub-set of taxa representative of the range of biota has to be chosen. Population sizes, reproductive status and locations of these taxa should be recorded from the monitoring sites established for indicators 1.2 and 1.3 above, in a collaborative program between researchers and managers.

Links to Montreal indicators:
Goes beyond Montreal 1.2b; necessary to be relevant at regional scale. Measuring changes in range incorporates Montreal 1.3a. Population levels incorporates Montreal 1.3b.

9. Amounts of genetic variation within and between populations of species identified at being at risk of reduced variation due to human activities

Rationale:
Genetic variation is a major component of biodiverrsity. Direct measurements can be made of components of genetic diversity.

Analysis and interpretation (including targets):
The most appropriate methods that can be employed involve direct analysis of DNA. Details of which analyses are most practical and yield the most relevant information should be obtained from experts in this field. The greatest problem with data collection is that the species of most concern are the rarest and, therefore, the most difficult to sample in large numbers. Snap-shot samples tell us little about the sustainability of populations and collection of enough samples through time to draw conclusions about

changes could be difficult. There remain difficulties in interpreting what the size of changes in genetic diversity mean in terms of sustainability of populations, although loss of genetic diversity in itself could be regarded as of concern in its own right. A further difficulty is distinguishing natural changes in genetic diversity from changes induced by human activities in forests.

Monitoring design and strategy:
Sampling within species should be stratified across its range. Numbers of samples should be determined in relation to the amount of variation expected and the statistical power of the anticipated analyses. Control and treatment populations should be sampled so that the effects of forest management can be distinguished from natural changes in genetic diversity. Like monitoring of population parameters, the necessary sampling intensity for this indicator could be expensive and cost effectiveness should be reached by reducing the number of species and or genetic analyses rather than the number of replicates, so that unequivocal conclusions can be drawn.

Outputs:
Data on measures of genetic variation within populations of key species.

Data requirements:
Laboratory analyses of samples from populations of key species of organisms.

Links to Montreal indicators:

Encompasses but goes beyond Montreal 1.3a; a more direct measurement as suggested by the Montreal workshop.

10 Extent of native forest and plantations of indigenous species that have genetic resource plans prepared and implemented

Description:
This is an indicator of process that, in the absence of easily measured and interpreted indicators of outcome gives a measure of assurance that appropriate steps are being taken to move towards indicators of outcomes.

Rationale:
Development of genetic resource plans should consider the adequacy of existing information, assess the risks and consequences of any inadequacies, and propose strategies, priorities and resources to correct any inadequacies.

Analysis and interpretation (including targets):
Target should be plans for all forests; if risks are small and consequences mild then plans might contain minimal detail but a formal assessment of risks and consequences should be made and published. Otherwise, there can be little confidence that Ecologically Sustainable Forest Management is achievable.

Monitoring design and strategy:
Monitor lists of completed and published plans.

Outputs:
Report on plans completed and published.

Data requirements:
Collation of completed and published reports by agencies.
Links to Montreal indicators:
Encompasses Montreal 1.3c

11. Proportion of forest types for which formal forest-type specific strategies and prescriptions for management of biodiversity exist

Description:
This is an indicator of process that, in the absence of easily measured and interpreted indicators of outcome gives a measure of assurance that appropriate steps are being taken to move towards indicators of outcomes.

Rationale:
Development of strategies and prescriptions for management of biodiversity should consider the adequacy of existing information, assess the risks and consequences of any inadequacies, and propose strategies, priorities and resources to correct any inadequacies.

Analysis and interpretation (including targets):
Target should be published strategies for all forests; if risks are small and consequences mild then plans might contain minimal detail but a formal assessment of risks and consequences should be made and published. Otherwise, there can be little confidence that Ecologically Sustainable Forest Management is achievable.

Monitoring design and strategy:
Monitor lists of completed and published strategies.

Outputs:
Report on strategies completed and published.

Data requirements:
Collation, by agencies, of strategies completed and published.

Links to Montreal indicators:
Montreal 7.2

12. Existence of processes that ensure the best available scientific information is used in formulating management prescriptions for biodiversity and provide ongoing review of practices in the light of new knowledge

Description:
This is an indicator of process that, in the absence of easily measured and interpreted indicators of outcome gives a measure of assurance that appropriate steps are being taken to move towards indicators of outcomes.

Rationale:
In the absence of clear indicators of outcomes of management for biodiversity, a degree of confidence is gained if ongoing processes are transparent and seek and accept the best advice from qualified practitioners.

Analysis and interpretation (including targets):
Adequacy of the processes should be assessed by independent assessors. This is being done as part of Ecologically Sustainable Forest Management Project 6 on institutional arrangements. The processes should be assessed as part of ongoing reviews of institutional arrangements.

Monitoring design and strategy:
Regular (5-10 yearly or when significant changes are made) independent assessment of processes.

Outputs:
Published assessment reports.

Data requirements:
Information obtained from agencies by assessment panels.

Links to Montreal indicators:
Montreal 7.2 and 7.4

13. Existence of processes that define the type, quality and extent of data required to support planning for biodiversity conservation, assess how well these requirements are met, perform risk and uncertainty analyses on the data and ensure that uncertainty and risk are considered in the planning process

Description:
This is an indicator of process that, in the absence of easily measured and interpreted indicators of outcome gives a measure of assurance that appropriate steps are being taken to move towards indicators of outcomes.

Rationale:
Management plans are formulated on the best available information but, often, there is little consideration of the adequacy and risks associated with the information. A degree of confidence in management plans for biodiversity is gained if there are clear processes that assess the adequacy of the underlying information and take this into account in risk spreading or risk aversion strategies. These processes should include an assessment of the scope and representativeness of survey effort in the region.

Analysis and interpretation (including targets):
Adequacy of the processes should be assessed by independent assessors. This is being done as part of Ecologically Sustainable Forest Management Project 6 on institutional arrangements. The processes should be assessed as part of ongoing reviews of institutional arrangements.

Monitoring design and strategy:

Regular (5-10 yearly or when significant changes are made) independent assessment of processes.

Outputs:
Published assessment reports.

Data requirements:
Data on published reports from agencies.

Links to Montreal indicators:
Montreal 7.2 and 7.4

14. Amount and nature of investment in research and development in relation to that assessed by experts to be required to maintain acceptably low levels of risk to biodiversity from management practices

Description:
This is an indicator of process that, in the absence of easily measured and interpreted indicators of outcome gives a measure of assurance that appropriate steps are being taken to move towards indicators of outcomes.

Rationale:
Verification that Ecologically Sustainable Forest Management is being achieved with respect to biodiversity can only be gained once there is adequate scientific underpinning of indicators. In the absence of this underpinning, a degree of confidence can be gained if adequate and well targeted ongoing research and development is under way.

Analysis and interpretation (including targets):
The target should be a well balanced scientific advisory panel, representative of the range of scientists and institutions with expertise on biodiversity in the Eden region. This panel should advise on research priorities and targets in the light of assessments of risks and consequences of inadequate knowledge. Performance of management agencies could be gauged against the recommendations of this panel. It is likely that expenditure will fall short of that desired, due to financial limitations. The degree of shortfall is a measure of the risk the community is prepared to accept due to uncertainty about the processes affecting biodiversity. Great care should be taken in developing the guidelines for the advisory panel, so that its recommendations are realistic and focussed on vital rather than desirable research and development. Even so, there will always be difficulty assessing this indicator quantitatively and it represents more of a safeguard than a robust indicator of change.

Monitoring design and strategy:
Assess expenditure on research and development and what it is spent on in relation to recommendations of advisory panel. Also assess existence, composition and independence of advisory panel.

Outputs:
Report on assessment as part of annual reports.

Data requirements:
Data on research expenditure by project; recommendations of advisory panel.

Links to Montreal indicators:
Montreal 7.5

SUMMARY OF INDICATORS AND THEIR QUALITIES

Table 3.1 Indicators proposed for the Eden Regional Forest Agreement region scored against the criteria specified in the brief (see Section 0). Numbering in left column is from State of the Environment report. Criteria 1-7 refer to: 1 - Linked to criteria; 2 - Scientific basis; 3 - Clearly understandable and

interpretable; 4 - Able to measure change; 5 - Cost effective; 6 - Feasible at relevant scales; 7 - Provides early warning of potential problems; 8 - Aggregative.

TABLE A3.1
SUMMARY OF INDICATORS AND THEIR QUALITIES

INDICATOR		CRITERIA							
		1	2	3	4	5	6	7	8
1.1	Extent of forested area by forest type	Y	Y	Y	Y	?	Y	?	Y
1.2	Representation and extent of forest types, and the biotic and abiotic variation within them, within protected areas	Y	Y	Y	Y	?	Y	Y	Y
1.3	Maintenance of biodiversity within forest types outside reserves	Y	Y	Y	Y	?	Y	Y	Y
1.4	Degree of fragmentation within each forest type and across the overall forest estate	Y	Y	?	?	?	Y	Y	Y
1.5	The number and identity of known forest dwelling species within each forest type	Y	Y	Y	Y	Y	Y	N	Y
1.6	The number and identity of forest dwelling species considered to be at risk of not maintaining viable populations as determined by legislation or scientific assessment, classified by status (threatened, rare, vulnerable, endangered, extinct)	Y	Y	Y	Y	Y	Y	N	Y
1.7	Population viability parameters for species of concern	Y	Y	?	Y	?	?	Y	Y
1.8	Population levels, range and reproductive status of selected species from diverse habitats monitored across their range	Y	Y	Y	Y	?	?	Y	Y
1.9	Amounts of genetic variation within and between populations of species identified at being at risk of reduced variation due to human activities	Y	Y	?	Y	?	?	?	Y
1.10	Extent of native forest and plantations of indigenous species that have genetic resource plans prepared and implemented	Y	Y	Y	Y	Y	Y	N	Y
1.11	Proportion of forest types for which formal forest-type specific strategies and prescriptions for management of biodiversity exist	Y	Y	Y	Y	Y	Y	N	Y
1.12	Existence of processes that ensure the best available scientific information is used in formulating management prescriptions for biodiversity and provide ongoing review of practices in the light of new knowledge	Y	Y	Y	Y	Y	Y	N	Y
1.13	Existence of processes that define the type, quality and extent of data required to support planning for biodiversity conservation, assess how well these requirements are met, perform risk and uncertainty analyses on the data and ensure that uncertainty and risk are considered in the planning process	Y	Y	Y	Y	Y	Y	N	Y
1.14	Amount and nature of investment in research and development in relation to that assessed by experts to be required to maintain acceptably low levels of risk to biodiversity from management practices	Y	Y	Y	Y	Y	Y	N	Y

* Please note: We are not confident that we have assessed cost effectiveness in the most useful way. At present it really relates to whether the measure will be expensive. However, as the indicators proposed are all considered highly important, a high cost may well be justified if Ecologically Sustainable Forest Management is considered highly important.

APPENDIX 4
Expert Identified Indicators for Maintenance of Productive Capacity of Forest Ecosystems

INTRODUCTION

The criterion focusing on the productive capacity of the entire forest estate for both wood and other forest products is clearly an essential component of sustainability, and relates directly to commercial, ecological, and socio-economic activities. The consideration of this criterion is the productive capacity of the forest estate rather than production at the individual coupe level or other small scale level.

A forest site has an inherent capacity to support a level of forest growth that is set by soil fertility and the climatic regime. The realized productivity on a site is affected by historical factors including wildfire, disease, climatic variability, and silvicultural operations. In commercial forests (from timber production), the relative importance given to conservation values and wood production is a critical determinant of the realized rate of wood production. The relative priorities affect aspects such as age-class distribution (even-aged versus multi-aged), rotation length, and whether thinnings are harvested. In general, increased emphasis on management to increase conservation values will reduce the amount of wood production per unit time for a given area of forest. Therefore, clear and agreed forest management objectives need to be set, leading to selection of indicators reflecting this management.

Total production (wood and other products) from forests depends on the area of forest available for production and the rate of production per unit time. It is the product of these two factors that is the main consideration of this criterion. On any given area, the productivity of the forest changes over time commencing with low rates of production, moving through a rapid phase, and then slowing to zero net growth in mature stands. A key issue in many areas is the transition from mature forest to regrowth forest. Mature forests have zero or low productive capacity; whilst regrowth forests with varying age structure, have a higher wood production capacity. Harvesting a mature forest will move from system with high storage low production to a low storage higher production system. Both are important elements in considering sustainability and will change over time.

While total productivity is an important issue, the rate of production of trees in commercial size classes is a key issue. Young forests may be very productive but it may be several decades before any logs of a size which are merchantable will be produced. In such a situation, total production can be high, merchantable production is essentially zero and yield (from existing mature forest) is moderate. Yield would be much less than total production but apparently higher than merchantable production, raising the issue of the need for several indicators taken in conjunction and the need for modifications over time as information is improved. The time period for analysis and reporting will influence the interpretation of results and whether historical information is included to assist in establishing base lines and comparisons (Horne and Carter 1992, Turner 1996).

Information for many of the indicators will need to be obtained from different sources and by a variety of organizations. Any differences in the methods of obtaining information will make collation and analysis more difficult. The issues of methodologies, quality and verification, data analysis, maintenance of data bases, and reporting are not being generally addressed but are recognised as crucial issues.

INDICATORS OF CHANGE OF PRODUCTIVE CAPACITY

A series of indicators are proposed in relation to productive capacity. These are initially selected from the Santiago Declaration indicators and modified to increase relevance for the NSW South Coast conditions.

Indicator 2.1. Area of forest land and the net area of forest land available for timber production, listed by all land tenures.

Comment:
The objective is to provide a quantitative estimate of the land base available for timber production and other uses according to different categories of ownership. Such information is critical for calculating annual wood production and for interpreting long term trends in wood production. The accuracy and scale of reporting need identification but such a system should be accessible through a Geographical Information System. Reporting should be on an annual basis to provide indications of trends (Turner 1996, Turner and Pribble 1996, Dignan et al. 1996, Lutze and Campbell 1997). The information is partly on total land resources and there will be the identification of total gross areas identified for production and within these, there will be non-productive areas which need to be identified, such as streamside reserves, roads, log dumps and other inaccessible areas.

The information is available for State-owned forested land in the south-east but information on privately owned land is less well known and would need to be reviewed.

Analysis:
The analysis will be based on the changes, over time, of the timber production land base. This information is part of an analysis determining quantities of available timber. The basis for comparison is the stated production objective. This indicator is linked to indicators 2.2 and 2.3.

Indicator 2.2. Extent of area by major native forest type and age class, listed by all land tenures.

Comment:
In the Santiago Declaration, this is considered to be a biodiversity indicator but is also a key productivity indicator. The stratification of forests by agreed types and age class is important in productivity calculations and in terms of potential quality of the product. Age class may be within broad groupings or relate to structure but needs to be an agreed broadly applicable system (Richards et al. 1990, Dignan et al. 1996, Turner and Pribble 1996). Accessibility should be through a Geographical Information System. The information will be immediately available for much of the State Forest land and that of National Parks but whether it is accessible for private lands needs to be reviewed.

Analysis:
The analysis will be in terms of changes in area over time and is a component of estimates of available timber. This indicator is directly linked to Indicators 2.1 and 2.3.

Indicator 2.3 Total standing volume and rates of change, by species and size classes, on native forest land available for timber production, listed by land tenure.

Comment:
Estimation of standing volume by size class provides an indication of the supply opportunities, and reporting over time allows trends to be seen. Size class and species are used rather than more subjective estimates of merchantability. Merchantability can change with time and market demands and the relative values of species or size classes can be reported by commentary with this Indicator. Reporting would need to be based on periodic assessments with intervening estimates from growth models (Bi 1994, Carter 1994, Turner 1996). Further, the rates of growth provide information on potential future yields.

For such a system to provide accurate information, there will need to be systems, across all tenures, of permanent growth plots, assessment systems and collation of information for development of growth models. Part of this is in place at this time (Bi 1994).

Analysis:
The analysis will include indicators 2.1 and 2.2 to provide total estimates of total available volume and production. Changes will need to be monitored over time and compared with production objectives as stated in Plans of Management. Research on growth and development of growth models and estate systems is of critical importance.

Indicator 2.4 Area and growing stock of commercial plantations of native species, listed by land tenure.

Comment:
The intent is to provide an estimate of the extent and rate of development of plantations as a source of timber. The areas and estimates of growing stock should be updated and reported annually (Stanton 1992, Turner and Pribble 1996). Areas of State Forest Eucalyptus plantations have been reported by Stanton (1992) and Faunt (1995) but no information was provided on areas of private land nor was productivity addressed but the basis for reporting is available.

Analysis:
Analysis will be in terms of change in area (against planned objectives according to Regional Plantation Strategy), and the levels of productivity (compared to set standards).

Indicator 2.5 Annual removal of wood products compared with the estimated sustainable volume, for all land tenures.

Comment:
The intent of this indicator is to provide a comparison between what is estimated as the sustained yield and the quantity harvested on an annual basis. As such, it is one of the key parameters in commercial forests. Where the forests are not normal, as in the south-east, such an indicator is difficult to utilise and interpret and as such will need development over time. The estimated sustainable yield is usually calculated on a long term basis and reporting of this indicator, where fluctuations are involved, should be on a five-year basis. The information on yield is the total quantity of timber sold from State-owned forests marketing systems with estimates of private land.

Analysis:
Three indices may be involved, namely:

- Annual yield compared with estimated long term sustainable volume;
- Annual yield compared with annual total production;
- Annual yield compared with annual production in merchantable size classes.

These are only broad parameters and will be need to be refined over time with separation of individual species (Bi 1994, Turner 1996). The yield is the total production (not based on a sample) while production is based on models or from samples.

Indicator 2.6 Density, species composition and growth of regeneration in the third year after harvesting ceases.

Comment:
The objective is to obtain an indication of the productivity of the regenerating stand. Standards for density, species composition and growth rates need to be set on a forest type basis. The estimates would be obtained on a stratified sampling basis and applied to all tenures. Whether such an approach is required after disturbance such as wildfire needs to be considered (Bridges 1983, Baker et al. 1991, Dignan et al. 1996).

Analysis:
The indicator uses the developing stand as the integrated index of site condition. The base line will be established minimum levels of regeneration and growth. The index of regeneration species composition is the species composition prior to harvesting.

Indicator 2.7. Number and level of research projects on growth and yield by all agencies across all tenures.

Comment:
As the management and indicators are evolving, research is essential to develop best practices. The programs should be open and cover a range of organisations, but should be of high quality and open to peer review.

Analysis:
A report on expenditure, organisation, and projects and outputs to be provided.

APPENDIX 5
Expert Identified Indicators of Forest Ecosystem Health and Vitality

BACKGROUND ISSUES

Definition

The Montreal process defines the healthy ecosystem as one in which "a full complement of biological components are present with recruitment, growth and energy and nutrient fluxes operating in each component". This is a separate and distinct measure from biodiversity.

Our current state of knowledge and understanding

In considering the criterion of "Ecosystem Health and Vitality", various authors and expert workshops throughout the world have included a wide range of different indicators reflecting the many components that go to make a functioning ecosystem. These have been reviewed in several places recently (eg. See Hamblin 1997) and we have not repeated that review here. Below, however, we comment on some aspects of ecosystem function and how it might be measured that we think are new contributions to the debate about forest ecosystems.

Our research into ecosystem functioning in productive and conservation landscapes undergoing both degradation and rehabilitation has indicated that a "healthy" ecosystem is one that regulates and distributes ecosystem resources in a manner that self-sustains vital ecosystem processes. We have used the concept of a functional continuum to describe the responses of landscapes to various pressures such as the more natural and episodic disturbances of fire and storms and the human-induced disturbances of grazing, mining or harvesting of plant products.

A functional landscape is one that conserves its material flows of ecosystem resources such as water, nutrients, organic carbon, soil substrate and propagules of seeds, fungal spores, bacteria and invertebrates. A dysfunctional landscape is one that leaks these ecosystem resources at a rate higher than the replacement or renewal rate of the resources through processes of erosion, overharvesting, increased fire frequencies or land clearance.

Ecosystems are housed within landscapes and are dynamic assemblages of biological diversity and ecological processes influenced by the parent material and topography of the landscape, the global and regional climate, the passage of time, the disturbance regime and the potential biota available to take advantage of new ecosystem opportunities within the landscape. Functional groups of biota (primary producers, consumers and decomposers) maintain nutrient cycling and the biodiversity linkages between the soil-plant-fauna components of ecosystems, that ultimately facilitate ecosystem sustainability. From this framework, the ecosystem health and vitality of a forest ecosystem can be viewed as an emergent property of this ecological complexity.

An indicator is an attempt to find a simple surrogate for this complexity. To extend the human health metaphor to the ecosystem level, we are seeking a simple measure of the whole state or condition of the ecosystem in much the same way as we take the temperature or pulse of a patient. Clearly, an ecosystem is immeasurably more complex than a single organism. The challenge in the development of useful indicators of ecosystem health and vitality is to recognise what is and what is not reliably known about the use of an indicator in terms of the basic scientific understanding of the ecological processes being measured and the difference between correlation and causation in ecology.

Our view of indicators is that they are in an early state of development, that they are different to environmental measurements and that they are currently a prediction rather than a definition. We also recognise that there are no easily implemented and readily available universal indicators of ecosystem health and vitality at the present time. At best, the Montreal Indicators are a useful process for starting the development of a reliable set of ecosystem health indicators for Australian forest ecosystems. However, it is clear that these indicators are not a surrogate for ongoing research and development into Australian forest ecosystems and particularly the development of GIS and spatial analysis techniques required for best practice ecosystem management of Australian forest ecosystems.

Above all, the development of an ecosystem management focus in the Eden Management Area will be imperative for the development and implementation of a set of indicators of forest ecosystem health and vitality. This includes assigning ecosystem mapping units to ecologically meaningful units of the landscape that have repetitive patterns of ecological properties and processes, and consequently, forest management practices. Without this spatial understanding of the physical, biological and chemical processes driving ecosystem function and the changing make-up of biological diversity, together with a mappable data base of the key landscape level disturbances such as fire, harvesting, grazing and other forest management activities, a set of ecosystem health and vitality indicators will be scientifically meaningless and useless for forest managers.

OUR APPROACH

One desirable approach to our task, given enough time, would have been to convene workshops of experts on ecosystem health to review the literature on ecosystem function indicators and to develop a conceptual landscape ecology framework for understanding the meaning of ecosystem health in our Australian forest landscapes. With a commonly shared understanding of the meaning of these terms and their relevance to Australian forest ecosystems we would have been able to assemble a comprehensive list of potential indicators and rank this list in relation to the criteria for useful indicators indicated in our brief (see below). As indicated in our brief, the criteria for a useful indicator are that it must:

- have a sound scientific basis;
- be clearly understandable and interpretable;
- have costs appropriate to benefits;
- be feasible and realistic to measure;
- have targets and thresholds built in;
- contribute directly to continuous improvement of management;
- be sufficient when taken together to assess whether Ecologically Sustainable Forest Management is being achieved.

We suggest that another should be added:

- provide early warning of potential problems

Time and budget have not allowed us to follow the path outlined above. Therefore we have drawn extensively on two processes that have brought experts together recently for very similar tasks. Firstly, the Commonwealth Government, through Environment Australia State of Environment Unit, recently commissioned a report on indicators of land resources in Australia (Hamblin 1997). Although this report is still in draft form and under review, we have drawn on it for insights into the latest ideas on indicator development in Australia. At this stage we do not have permission from the author and Environment Australia to release specific details. However, we do not anticipate problems once the report is finalised.). Secondly, the Montreal Implementation Group have recently run a workshop of experts to discuss application of the Montreal Criteria and Indicators at the regional scale in Australian forests. The workshop on ecosystem health and vitality was attended by one of our team and we have drawn on insights gained at that meeting into the opportunities and difficulties of developing indicators for ecosystem health and vitality in Australian forest ecosystems.

We also recognise that perceptions and concerns of the public are at least as important as scientifically determined issues when developing indicators that will give all stakeholders confidence that achievement of Ecologically Sustainable Forest Management is being monitored adequately. Accordingly, we have attended two meetings of the Eden Regional Forest Forum and have requested and received written inputs from members of the forum.

We have summarised the information and opinions gathered in these ways in Appendices 1 and 2. We have dealt with the information in four main ways. Firstly, we have generated our own ideas about what would constitute an adequate set of indicators and have assessed these ideas against those coming from the State of the Environment, Montreal Process and Regional Forest Forum reports. Secondly, we have gone through the lists of possible indicators put forward in the various reports and assessed each against the criteria for useful indicators given in our brief. Thirdly, we have cross-checked to make sure that all concerns expressed by

stakeholders have been addressed in some way within the set of indicators recommended. Fourthly, we are circulating drafts of this report for comment among as many stakeholders and relevant experts as time would allow.

Finally, we have recognised in these meetings, aimed at adapting the Montreal Indicators to Australian forests, that there is a tendency to seek simple indicators, often single indicators, for the complexity of forest ecosystem processes. We wish to strongly caution against this belief in the simplicity of indicators. Our experience and recent research now shows that it is possible to rapidly assess the "health" of some components of an ecosystem that contribute to ecosystem function and self-sustainability. However, there is a major need for scientific understanding of ecosystem processes and the use of rigorous scientific method in developing, implementing and interpreting these ecological indicators, similar to that used for water quality criteria or the use of macroinverterates for assessing aquatic health.

In short, it should be clearly recognised by all concerned that there are no easy indicators of ecosystem health and vitality but plenty of promise if operationalised in the context of adaptive ecosystem management by forest managers.

RECOMMENDED KEY INDICATORS

Area and Percent of Forest Affected by Processes (Including Threatening Processes) or Agents Beyond the Range of Historic variation or other thresholds for concern.

Rationale:

Agents such as pests, disease, competition from exotic species, presence of exotic predators, land clearance, changed hydrology, use of pesticides and other chemicals, and fire potentially alter the state or condition of the forest, and functioning of the forest ecosystems, if they go beyond the normal range of variability and especially if they cross some critical threshold.

Issues:

For many of these processes, the normal range of variability is not known. It is also difficult to assess what the normal range of ecosystem health might be in an Australian landscape prone to episodic disturbances that are a necessary part of ecosystem development such as fire. Implementation of this indicator will, therefore, depend on documenting these ranges of variability. Foxes and altered fire regimes are particularly important agents in Eden. Other important agents will be reported by the Ecologically Sustainable Forest Management "Response to Disturbance" project.

Data:

Identification of potentially threatening agents should come from the expert workshops run under the Ecologically Sustainable Forest Management "Response to Disturbance" project. Data on fox activity, pests, diseases and weeds should come from stratified surveying of forest types and be maintained in readily accessible databases. Extent, severity and cause of all fires should be recorded digitally in databases. The Nadgee fire and fauna studies conducted by CSIRO Wildlife and Ecology provide a 20 year record of fire frequency and its effects on habitat complexity, small mammal fauna and feral animal abundance. Threatening processes relating to soil and water are dealt with under that criterion but their areal extent should be assessed here.

Methods:

Fire
Mandatory reporting of all fires in public forests; record location and extent of all fires using API and/or satellite imagery; frequency of assessment will depend on potential rate of forest alteration ; establish extent of knowledge of past fire history from experts and fill gaps using appropriate techniques such as historical air photos, soil carbon analyses and oral and written history.

Pests and diseases
Remote sensing and routine surveying to detect symptoms; routine surveillance of areas where management is active; stratified survey within each forest type for organisms and symptoms; frequency and sampling effort in relation to perceived risk.

Exotic biota
Remote sensing (including API) and routine surveying to detect organisms (eg. weed infestations); routine surveillance of areas where management is active; stratified survey within each forest type for organisms; frequency and sampling effort in relation to perceived risk and assumptions behind management prescriptions

Use of pesticides
Quantities applied per catchment is one convenient measure that would give indication of concerns with respect to pesticide use. This could also be mapped as a GIS layer. A knowledge of those forest ecosystems prone to loss of ecosystem resources will indicate which catchments are likely to be leaking pesticides, particularly pyrethroids and any long-lived pesticides, into the more vulnerable aquatic ecosystems. Measurement of pesticides in non-target species and run-off into streams are measurements that should be considered for development. We have not had time to assess the issues relating to pesticide use in Eden any further in this consultancy.

Other processes
Refer to soil and water, biodiversity and forest productivity criteria and indicators.

Interpretation (including targets):

This will vary from forest ecosystem to ecosystem. Ideally, no parts of the region should fall outside natural variation or, if they do, there should be confidence that this is a transient effect and not likely to have long term flow-on effects on other parts of the landscape. Firm targets cannot be set until natural variation is documented. In the meantime, expert opinion is the realistic way to interpret trends in this indicator. For many threatening processes, such as introduced exotic species, natural variation is not a meaningful measure. For these, expert knowledge should be sued to establish thresholds for concern and these should be the subject of ongoing adaptive management, research and development.

Monitoring design and strategy:

Some components of surveillance could be incorporated into auditing of management practices (on all tenures); otherwise stratified sampling across forest types and environments is required. Frequency of sampling and amount of replication should be determined by considering the consequences from missing outbreaks at early stages, the likely number of samples required to detect outbreaks while they are at controllable scales, and the number of forest types for which risks are thought to be high. In many cases it will not be necessary to monitor abundance precisely but rather to assess whether distribution and abundance exceed thresholds of concern. The design of monitoring programs could differ between these objectives and the latter could be more cost- effective.

Links to Montreal indicators:

Amalgamation of Montreal 3.1a and 3.1d proposed by the recent Montreal Implementation Group workshop

Area and Percent of Native Forests and Plantations, on All Land Tenures, With Management Plans in Place for Control of Pests, Diseases and Exotic Species

Rationale: This is an indicator of institutional process that should be dealt with by Ecologically Sustainable Forest Management Project 6. However, it performs an important integrative role in relation to Forest Ecosystem Health and Vitality for several reasons. Firstly, in the absence of clearly definable targets for areas affected by pests, diseases and exotic species, the existence of management plans that utilise the best available expert knowledge gives a degree of reassurance that the issues are being addressed formally and rigorously. Secondly, the existence of a management plan, provided it meets certain minimum standards (see below), is a surrogate for surveys having been performed and risk assessments undertaken.

Issues: The management plans should genuinely utilise the best available scientific and statistical knowledge, be based on an assessment of data needs data availability, and have performance targets and adequately funded monitoring and continuous improvement programs built in.

Data: This should be an attribute of an overall forest ecosystem management framework for the Eden Management Area available as a layer in the GIS for the area..

Methods: Record and regularly review progress on management plans by forest type and process or agent. Minimum standards for management plans should be assessed by a suitable degree of independent review.

Interpretation (including targets):

The target should be full coverage of all forest types by management plans. As a minimum, an assessment of data availability and the risks and consequences of all processes and agents in all forest types should be made and acted on in a management plan. Where risks and consequences are small, management plans might recommend little action but absence of a management plan should be regarded as a serious problem as it could mean incomplete formal assessments have been made.

Monitoring design and strategy:

To be determined as part of the development of the management plans themselves.

Links to Montreal indicators:

Links to Montreal Criterion 7, which deals with institutional arrangement; also incorporates Indicator 3.1e "Area and percent of plantations formally surveyed for health status and proportion damaged" suggested by the recent Montreal Implementation Group workshop.

Area and Percent of Forest Land Subjected to Levels of Specific Air Pollutants (eg. Sulphates, Nitrates, Ozone) or Ultraviolet B that may cause Negative Impacts on the Forest Ecosystem

Rationale: This indicator is significant in areas of North America, Europe and Asia where industrial and urban pollutants have accumulated in forest ecosystems acting as airshed sinks for chemicals such as nitrogen, sulphur, polyaromatics, acidity and lead. Forest health decline has been seen in the form of acid rain and selective tree death at altitudes where air masses concentrate urban and industrial pollutants.

Issues: In Eden, an airshed model would be needed to identify pollutant sources and ecosystem sinks before any data collection was undertaken. This may not be a high priority given the distance to significant point and regional sources. A more uncertain issue is the suspected rising level of ultraviolet B over southern Australia and its effects on vegetation. This is a research topic with little opportunity for management intervention at the forest ecosystem level.

Links to Montreal indicators:

Montreal 3.1b

Area and Percentage of Forest Land with Diminished or Improved Biological, Physical and Chemical Components Indicative of Changes in Fundamental Ecosystem Processes.

Rationale: An indicator that integrates across issues of soil, water, carbon, productivity and biodiversity is important because it provides measures of the status of fundamental ecosystem processes which sustain ecosystem health and vitality compared to analogue ecosystems with unmodified conditions.

Issues: This indicator can be addressed by measuring separately the areal extent of indicator values for soil, water, carbon, productivity and biodiversity criteria. We suggest here, however, a more truly aggregative indicator based on recent application of research by CSIRO.

The properties, processes and components of ecosystems fluctuate in time and space so that it is not possible to have simple measures of ecological complexity that have universal meaning. These fluctuations, or ecosystem dynamics, are part of the natural development and evolution of the ecosystem within the landscape. The rates of these processes, and trajectories of the ecosystems, have also changed in response to human-induced disturbances such as fire frequency, invasion by weeds and feral animals and land clearance.

In order to deal with these complexities and provide useful indicators of ecosystem health, we need to establish explicit and repeatable measures of ecosystem function that can be aggregated into indicators of changes in ecosystem health and vitality at local and regional levels. At base, we consider one of the expressions of the health of an ecosystem to be the rate of flow of energy and materials through functional groups of its biological diversity (primary producers, consumers, decomposers) within the ordered patterns and processes of a self-organising landscape. The degree to which the ecosystem captures, regulates and distributes these resources, principally water, organic carbon, nutrients and propagules, is an indicator of the function or health status of the ecosystem. A healthy ecosystem conserves ecosystem resources above a level that allows ecosystem sustainability and an unhealthy or dysfunctional ecosystem is one that is losing these resources and consequently the ability to self-sustain ecosystem function.

Data: There is a need for an understanding of fundamental ecosystem processes driving disturbance and species distribution and key biota contributing to ecosystem functioning, but not a detailed knowledge of the taxonomy or ecology of particular species. This understanding can be used to develop easily assessed indices of ecosystem state (see below). Spatial mapping and storage of this information in a GIS is important for moving to regional levels of analysis and interpretation.

Methods: The methodology of Ecosystem Function Analysis (EFA) for determining indicators of ecosystem development and health is under development and application in CSIRO Wildlife and Ecology . It has been developed in the Rangelands and applied there to degraded and natural systems. It has now been evaluated on 13 minesites around Australia including forests and woodlands in Mediterranean and savanna ecosystems. The theory and practice has been published (Ludwig et al., 1997; Tongway and Hindley, 1995) and it is now being applied for ecosystem reconstruction in a native forest in the ACT. Essentially, the methods involve field observations of parameters that assess aspects of soil nutrient cycling, soil stability and soil infiltration together with indicators of vegetation development and habitat complexity as surrogates of biodiversity. While the approach has a complex scientific underpinning, the assessments are simple and can be made by non-specialist staff with only a small amount of training in the recognition of diagnostic attributes of ecosystem components.

Interpretation (including targets):

The methods are applied to landscapes that have been modified, for example, through harvesting, and to analogue landscapes that have not been disturbed and can therefore act as reference sites. A chronosequence of sites are chosen so that the development of indicators can be viewed over time against those of the analogue sites.

Monitoring design and strategy:

These methods are easily operationalised with trained staff and could be readily adapted into forest managers survey schedules. Fixed transects of 50-100m running down slope in stratified ecosystems are used as reference sites for periodic measurement. These sites could be worked into a regional network of sites based on environmental heterogeneity and management practices.

Links to Montreal indicators:

Linked closely to Indicator 3.1.c

Existence of, and Compliance with, a Legislatively Supported Code of Forest Practices that Contains Clear and Enforceable Requirements Relating to the Full Range of Environmental Values and is Regularly Reviewed and Updated

Note: This requirement probably will be dealt with by Ecologically Sustainable Forest Management Project 6, which is dealing with institutional arrangements; but it is listed here to underline its importance as a complement to the indicators listed above

Rationale: The presence of one or more Codes of Forest Practice that cover all land tenures (including reserves) is a key requirement to give stakeholders confidence that the principles of Ecologically Sustainable Forest Management are institutionalised and required in on the ground management. Inclusion of requirements for soil, water, biodiversity etc. is a legitimate indicator for each of those criteria. To achieve healthy and vital forest ecosystems it is important that requirements relating to all processes are included and inter-related.

Issues: The minimum set of processes to be addressed in a Code of Forest Practices in relation to ecosystem health and vitality is; biodiversity, soil, water, productivity, carbon and nutrient balances, pests and diseases, exotic species, fire, pesticides and other chemicals and land clearance.

Data: Presence or absence of an approved Code(s) of Forest Practices covering all land tenures and both native forests and plantations; presence of processed for review of the Code(s) that ensure consideration of the best available information and are publicly transparent.

Methods: Confirm existence of Codes(s), inclusion of components listed above, and implementation of processes.

Interpretation (including targets):

All forest types and both native forests and plantations covered.

Monitoring design and strategy:

Assess at frequency of review of Code(s).

Links to Montreal indicators:

Montreal Criterion 7, which deals with institutional arrangements

SUMMARY OF OUR RECOMMENDED INDICATORS AND THEIR QUALITIES

Table 5.1 *Indicators proposed for the Eden Regional Forest Agreement region assessed (by us) against the criteria specified in our brief. Criteria 1-7 refer to: 1 - Linked to criteria; 2 - Scientific basis; 3 - Clearly understandable and interpretable; 4 - Able to measure change; 5 - Cost effective; 6 - Feasible at relevant scales; 7 - Provides early warning of potential problems; 8 - Aggregative.*

TABLE A5.1
SUMMARY OF OUR RECOMMENDED INDICATORS AND THEIR QUALITIES

INDICATOR		CRITERIA							
		1	2	3	4	5	6	7	8
3.1	Area and percent of forest affected by processes (including threatening processes) or agents beyond the range of historic variation or other thresholds for concern	Y	Y	?	Y	Y	Y	Y	Y
3.2	Area and percent of native forests and plantations, on all land tenures, with management plans in place for control of pests, diseases and exotic species	Y	Y	Y	Y	Y	Y	N	Y
3.3	Area and percent of forest land subjected to levels of specific air pollutants (eg. sulphates, nitrates, ozone) or ultraviolet B that	Y	?	N	?	N	N	?	?

	may cause negative impacts on the forest ecosystem								
3.4	Area and percentage of forest land with diminished or improved biological, physical and chemical components indicative of changes in fundamental ecosystem processes	Y	Y	Y	Y	Y	Y	Y	Y
3.5	Existence of, and compliance with, a legislatively supported Code of Forest Practices that contains clear and enforceable requirements relating to the full range of environmental values and is regularly reviewed and updated	Y	Y	Y	Y	Y	Y	N	Y

APPENDIX 6
Expert Identified Indicators for Conservation and Maintenance of Soil and Water Resources

INTRODUCTION

The forest soil resource is critical in maintaining the fixation and flow of energy, the cycling of water and nutrients, and in contributing to forest biodiversity. This criterion addresses the issues of soil productive capacity in relation to soil erosion, and stream ecosystem health, particularly stream water quality. Development of indicators in relation to soil and water involves considerations of spatial and temporal variation together with both on- and off-site effects of the management of forests. As such, any assessments will need to be placed in the context of other land uses adjacent to the forests.

Soil movement, either by physical displacement or erosional transport into streams, has implications for both forest and stream ecosystem health and productivity. However, the high levels of soil spatial variability and potential changes in properties over time, make assessment systems complex. Similarly, streams vary in properties rapidly over time and the scale (for example, catchment size) will vary in importance depending on whether the primary objective is protection of local stream ecology, local recreational use, or quality of water for further use (for example, human consumption). As any management will cause disturbance in both water and soil, the considerations are the degree of disturbance and the time period for those changes to revert to those experienced as a result of natural variation.

Harvesting of timber within forests will induce short term changes in soil and water characteristics, such as increased water yield, and possibly long term changes, such as severely compacted soil. A major issue is the degree of change which can be accepted if the forest is to be considered to be managed sustainably. Within these, there are interactions of time and space which need to be addressed, for example, is a small change of a large area more or less of a concern than an intense change on a very limited area. The development of indicators will require measurement and monitoring of change and provision of research to allow for establishment of guidelines for interpretation (Lubchenco et al. 1991, Turner 1996).

Changes in site conditions though modification of soil physical characteristics or loss of nutrients can lead to loss of productivity (rate of organic matter production) or a change in species composition (Turner et al. 1978). The changes will be site specific in that different sites will respond to different degrees to the same pressures (for example, level of soil compaction). As such, it is extremely difficult to generalize on the effect of an operation or to provide a single set of standards. A system of identifying a series of sites (strata) is required together with the factor(s) most likely to lead to potential declines in productivity, health or species composition identified for each site. That is, minor changes in soil bulk density may be a key factor on one site while loss of calcium as a result of harvesting may be a key factor on another site. While parameters such as soil organic matter are proposed for monitoring in many systems, it is naturally, a highly changeable variable. It may itself be an index of productivity rather than the cause of productivity differences, and there may be other direct measures more suitable for individual sites. The primary factor for each strata can then be monitored and key sites can be identified as those most vulnerable to change. On a Regional basis, comparisons with other land uses can be made.

While the development of indicators in relation to soil is primarily related to the long term productivity of the forest ecosystems, the assessment of water attributes may alternatively be surrogate measures of changes in the catchment (for example, soil erosion), or measures of the status of the aquatic ecosystem, or assessment of water quality or a concern of downstream ecosystems (for example, estuaries). The more precisely that the objectives are defined, the better will be the development of indicators.

Basically, it is proposed that the forest area be stratified for the development of indicators for the soil resource. Such a stratification would be hierarchical on the basis of geology, elevation and rainfall. Within such strata, there may need to be further sub-division into broad forest types, although it is expected that the primary environmental stratification would account for a significant proportion of the broad forest type variation (Turner et al. 1978, Richards et al. 1990). Such a stratification will differentiate forest areas according to soils nutrients (Kelly and Turner 1978, Ryan 1993, Grant et al. 1995) and physical attributes (Ryan et al 1989, Grant et al. 1995). While such a system would need clarification and verification, it is

assumed it would be developed and that the strata referred to in the indicators are derived from such a system.

Changes often occur over long periods of time and while recognizing the need for understanding the processes, such understanding is rarely available. Consider two particular native eucalypt forest ecosystems where we have reasonable levels of understanding of production and nutritional processes, they have required concentrated effort of study for more than 20 years (Attiwill et al. 1996, O'Connell and Grove 1996). Trials will need to be planned over the long term to answer very specific questions (Likens 1989, Dyck and Mees 1991).

INDICATORS FOR CONSERVATION AND MAINTENANCE OF SOIL AND WATER RESOURCES.

Indicator 4.1 **Extent and proportion of harvested forest land with significant physical disturbance.**

Comment:
The objective in developing this indicator is to assess changes in soil as a result of forest operations which may affect future forest productivity. Soil disturbance includes soil compacted or moved in operations such as harvesting, or transported and deposited by water or other natural processes (slippage). Soil compaction occurs from the use of equipment during harvesting operations (Incerti et al. 1987). Compaction reduces root development and hence plant growth will be significantly reduced (Lacey 1993, Walker and Reuter 1996). There are no apparent absolute relationships between specific soil densities and reduction in growth, such relationships appearing to be soil specific. Hence, biologically significant increases in soil compaction need to be identified in relation to the individual soils or at least the strata. Increased levels of soil erosion are perceived as a critical factor in the potential loss of productivity in forest systems together with potential secondary effects on aquatic systems. As such, it is crucial that an indicator be developed to assess the effectiveness of management procedures on its minimization. The aim is to provide an indicator of soil loss within harvested forest areas, rather than sources of sediment from roads and log dumps. Accelerated erosion is that increased above equivalent areas (geology, topography, soil type) in unlogged forest. Significant soil loss would be levels sufficient to cause a decline in biological productivity, as verified from research trials. Assessment would need to be undertaken by a methodology sampling a sub-set of paired harvested/unharvested coupes selected within the strata. Estimates of eroded areas within the catchment would be assessed by transects. After any operation, there will be a range of levels of disturbance some of which may enhance regeneration and growth. The assessment system, such as stratified transects within coupes, would evaluate categories including soil movement, erosion, and varying levels of compaction.

Analysis:
This is a very difficult indicator to develop, and often, the imprecise surrogate of runoff water turbidity or suspended sediment has been used as an index of level of erosion. The analysis will need to compare the levels (calculated areas and estimated proportions of harvested area) with an established desirable maximum level according to strata. For example, the maximum level of compaction on snig tracks within coupes may be 12% of area. For each strata, biologically significant levels of soil loss and soil compaction, need to be established to establish base lines.

Recommendation:
The reasonable use of such an indicator requires support of several areas of research. The first in the development of effective and accepted methodologies to statistically assess type, area, and degree of within-coupe soil disturbance. Secondly, field and laboratory trials are required to determine the levels of change in soil properties, over a range of soils, together with changes in growth and health of tree species to enable the establishment of biologically significant levels of change to be assessed.

Indicator 4.2 **Extent and proportion of harvested forest areas identified at risk from significant loss of key nutrients.**

Indicator 4.2a **Development of research and assessment working to characterize and quantify sites in relation to vulnerability to nutrient loss.**

Comment:

The nutritional status of forest sites in the Eden area has been shown to affect species composition, health and growth rates of trees and directly affect numbers and diversity of animals (Turner et al. 1978, Braithwaite 1983, Braithwaite et al. 1983, 1984, 1989, Kavanagh and Lambert 1990). There is high spatial and temporal variability in levels and availability of nutrients and hence the number of samples required for analysis is very high to detect change (Powers 1989). There is variability between sites in the factors which limit growth, or in the nutrients which limit growth, or in species composition, and also in their vulnerability to nutrient loss or change. It is proposed that a series of key forest sites be located within different strata, and that detailed nutrient inventories, budgets, and transfers be determined on the key sites. The objective is to define vulnerable elements on each site and the level of perturbation required (for example, number of harvests) before the effects of this vulnerability become evident (Turner and Lambert 1986, Stewart et al. 1990, Hopmans et al. 1993). The approach would require the location of a limited number of sites (within strata) some of which could be paired so there would be a logged and unlogged component. The inventory would need to include sampling of soils by depth for estimation of total, organic and "available" of each element to be made. Vegetation biomass and litter would also be inventoried. Turnover of nutrients would also be required. To further support this work, trials would be required (field and laboratory) on the availability of nutrients to trees, levels of nutrient removals and the effects of specific nutrient limitations. An end point would be the identification of vulnerable nutrients for different sites. Such an approach is long term and expensive and needs to be planned, however, applicable results will not be available in the short term. An interim indicator of progress would be the development of a detailed working plan, selection of sites, the commitment of resources for appropriate analyses, and the design of experiments to test nutrient vulnerability.

Analysis:
The analysis would consider the number of harvests required, by site, before a vulnerable nutrient has an effect on productivity, health, species mix, or other agreed factors. The specific analysis would be detailed in the research working plan, identified as indicator 4.2a. The production forest could be characterized, using strata analysis, into area of different number of harvests prior to an effect and the specific element potentially causing such an impact. The research would also need to identify appropriate ameliorative actions.

Recommendation:
The development of a detailed research working plan and its implementation, as outlined above, is critical.

Indicator 4.3 Variation of long term flow at points on key major rivers in the Eden Region.

Comment:
The Santiago Declaration indicators proposed that variation in stream characteristics be related to historical variation. Such information is not readily available. However, the flow and supply of water from forests is very important and the effects of forestry operations on the quantities available to downstream users need to be demonstrated. Water is used by vegetation to produce organic matter and the more productive a forest (due to changes in species, age, site quality) the higher will be water usage. Paired small catchments have been used in research to address the processes involved together with effects of forest management, but the objective is to consider water quantities (and in Indicator 4.4, quality) in rivers where water is used by landowners Likens et al. 1977, Bosch and Hewlett 1982, Cornish and Binns 1987, Hopmans et al. 1987, Mackay and Robisnson 1987, Turner et al. 1992, Lane and Mackay 1997). As forestry in the Eden area is one landuse within large catchments, changes in flow need to be addressed at different points and landuses in the catchment. It is proposed that a series of key water monitor points on major streams (Wallagaraugh, Towamba, etc), where land use changes occur, be established or maintained. The reporting would need to be in relation to climate and land use changes over time (Walker and Reuter 1996, Cornish 1997).

Analysis:
Time series and correlation analyses would be required to relate water yield changes in the catchment to land use (including effects of wildfire). Reporting would include different points down the stream and the outcome would be changes in discharge at various points attributable to land use changes (differences).

Indicator 4.4 Sediment and elemental concentrations and loadings at points on key major rivers in the Eden Region.

Comment:
The loadings are calculated from the quantity of water passing a point and the concentration of elements or sediment within the water. This can be converted, through knowledge of the catchment area, to average unit area losses. Use of the key points for studying discharge (Indicator 4.3) can be used to determine loadings of soluble and suspended material leaving larger forested catchments. This, by comparison with larger undisturbed catchments and within catchments covering different landuses further down the catchment, provide a basis for comparison and provide indicators of the major sources of material within catchments.

Analysis:
The data for concentrations would be compared with published guidelines (for example, ANZECC 1992) or agreed guidelines. The loading information would be analysed and presented on an annual basis and related to both agreed loading levels (in terms of kg/ha) or agreed percentage increases over equivalent undisturbed catchments. Such an analysis is critical for catchment management planning (Walker and Reuter 1996).

Indicator 4.5 Percentage of streams and rivers (for example, stream km) with normal chemical concentration levels above agreed targets.

Comment:
The indicator aims to consider the spatial variation within forest streams and the objective is to utilise repeated "snapshot" analyses to study changes and identify problem areas within the catchment (Gippel 1994, Turner et al. 1996, NRA 1994). The method has been extended beyond forest boundaries and allows for comparisons with landuse to be made (Boynton 1972). The system can be integrated with specific short term sampling to assess specific disturbances. The system can be integrated with biological assessment, although at this time there is insufficient information to allow for suitable biological indicators to be provided (Chapman 1992).

Analysis:
Sequential samplings be presented in terms of percentage of creeks falling within categories of each parameter. The objectives can be set in relation to the first data set (that is, set management strategies to improve this) or with guidelines such as ANZECC (1992).

Recommendation:
Research be undertaken to allow for the development of biological indicators to be used in conjunction with "snapshot" studies or with key monitoring sites.

Indicator 4.6 Development of nutrient budgets at catchment level.

Comment:
The aim is to develop broad nutrient budgets at a catchment level. The inputs and losses would need to be estimated (outputs in runoff would be obtained from key monitoring sites). The information would provide estimates of net gains and losses on a broad basis.

Analysis:
The net gains/losses would be gauged against both agreed levels and comparable information would be developed for adjacent land uses.

Indicator 4.7 Number and level of research projects on soils/water by all agencies across all tenures.

Comment:
As the management and indicators are evolving, research is essential to develop best practices. The programs should be open and cover a range of organisations, but should be of high quality and open to peer review.

Analysis:
A report on expenditure, organisation, and projects and outputs to be provided.

APPENDIX 7
Expert Identified Indicators for Effect on Global Geochemical Cycles

INTENT

To monitor the effects of forest management on geochemical cycles, so as to ensure that change is not negative with respect to that occurring in unmanaged forests.

BACKGROUND

Technically speaking, geochemical cycles relate to atmospheric inputs of chemicals, and to change in soil and rock chemistry. The focus of this criterion in the Montreal Process criteria and indicators was on carbon, because forest management can have a marked effect on ecosystem carbon budgets and that effect has implications for the enhanced greenhouse effect. The carbon in biomass is, strictly speaking, not part of the geochemical cycle. However, this carbon is an important part of the stock of carbon in forests, and is markedly affected by management practices (afforestation, harvesting, prescribed fire etc.) For the above reasons, the indicator recommended below relates only to carbon, and includes all components of the ecosystem.

Other processes that could significantly affect geochemical cycles are accelerated weathering and leaching, removal of nutrients in biomass and by fire, and accelerated erosion. Forestry operations (apart from fertilizer addition) generally have either no effect, or a negative effect on geochemical cycles. The net effect of changed cycles is a change in soil chemical properties, and this can be monitored under the criterion dealing with soil and water values. Only changes in carbon pools, rather than the actual amount, are considered here.

Potential Indicator

The indicator is only relevant at the regional or more aggregated scales, and not at the forest stand or management unit (coupe/compartment) scale.

Proposed indicator: change in the carbon stored in above-ground forest biomass when aggregated across all tenures on the basis that:

- the carbon stored in forest floor and soil is assumed on average to be unaffected by management; and
- carbon change is estimated from forest area, age, basal area/ht: biomass relationship, and assuming biomass is 50% carbon.

COMMENTS

In harvested native forests and plantations it will be possible to make reasonable estimates of change in above-ground biomass carbon based on mensurational models. Estimates of biomass carbon change in conservation reserves and on private land will be much less precise, and must be based on area and successional stage of forest types.

The effects of forest management on soil carbon storage can be very important. However, these effects are poorly understood, with data usually confined to a few research sites. To enable any credible estimate of soil carbon change at the regional scale would require considerable new research and monitoring. Changes in carbon in the forest floor could be estimated from a knowledge of forest type and time since the last fire.

Limited vegetation clearing, or new plantation establishment, in the Eden RFA region, will restrict the importance of change in soil carbon stores known to accompany such changes in land-use.

APPENDIX 8
References for Expert Indicators

BIODIVERSITY

Commonwealth of Australia (1997). Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia. Commonwealth of Australia, Canberra.

State of the Environment Advisory Council (Australia) (1996). Australia: State of the Environment. CSIRO Publishing, Melbourne.

PRODUCTIVE CAPACITY AND SOIL AND WATER

Anon (1994a). Sustainable forestry, the UK Programme. HMSO, London ,32 pp.

Anon (1994b). Toward a new era in sustainable forestry. The Canadian Forest Service Strategic Plan for Science and Technology: 1995-2000. Natural Resources Canada, Canadian Forest Service, Ottowa 11 pp.

Attiwill, P.M. (1991). Nutritional resilience of wet sclerophyll forest: recovery after disturbance. p. 172-179. In (Ed. P.J. Ryan) 'Productivity in perspective'. Third Australian Forest Soils and Nutrition Conference.

Attiwill, P.M., Polglase, P.J., Weston, C.J. and Adams, M.A. (1996). Nutrient cycling in forests of south-eastern Australia. p. 191-228. In (Eds. P.M. Attiwill and M.A. Adams). Nutrition of Eucalypts. CSIRO, Melbourne. 440 pp.

Australian and New Zealand Environment and Conservation Council (ANZECC). (1992). Australian water quality guidelines for fresh and marine waters. Canberra.

Baker T.G., King, M.R., Rab, M.A., Maheswaran, J. and Pearson, A. (1991). Spatial variation in soil disturbance and seedling growth in harvested and regenerating Eucalyptus regnans forest. Proc 3rd Australian Forest Soils and Nutrition Conference. 206 pp.

Bi, H. (1994). South-east regrowth forest growth and yield modelling: design, method and progress. State Forests of New South Wales Research Paper No.24. 38 pp.

Bosch, J.M. and Hewlett, J.D. (1982). A review of catchment experiments to determine the effects of vegetation changes on water yield and evapotranspiration. J. Hydrol. 55: 3-23.

Boynton, J.L. (1972). Managing for quality - a plan for developing water quality surveillance programs on national forest in California. p. 84-90. In: (Ed. S. Csallany) Watersheds in transition. Proceedings of Symposium "Water quality in transition', Fort Collins.

Braithwaite, L.W. (1983). Studies on the arboreal marsupial fauna of eucalypt forests being harvested for woodpulp at Eden, NSW. I. The species and distribution of animals. Aust. Wildl. Res. 10: 219-229.

Braithwaite, L.W., Dudzinski, M.L. and Turner, J. (1983). Studies on the arboreal marsupial fauna of eucalypt forest being harvested for woodpulp at Eden, NSW. II. Relationship between the fauna density, richness and diversity, and measured variables of habitat. Aust. Wildl. Res. 10: 231-247.

Braithwaite, L.W., Turner, J., and Kelly, J. (1984). Studies on the arboreal marsupial fauna of eucalypt forest being harvested for woodpulp at Eden, NSW. III. Relationships between faunal densities, eucalypt occurrence and foliage nutrients and soil parent materials. Aust. Wildl. Res. 11: 41-48.

Braithwaite, L.W., Austin, M.P., Clayton, M., Turner, J. and Nicholls, A.O. (1989). On predicting the presence of birds in Eucalyptus forest types. Biol. Cons. 50: 33-50.

Bridges, R.G. (1983). Integrated logging and regeneration in the silvertop ash-stringybark forests of the Eden Region. Forestry Commission of New South Wales Research Paper No. 2. 27 pp.

Carter, P. (1994). Factors influencing stand volume increment in regrowth eucalypt forests in NSW: Provisional results from the PGP system. State Forests of NSW Internal Report. 27 pp.

Chapman, D. (Ed). (1992). Water quality assessment: a guide to the use of biota, sediments and water in environmental monitoring. Chapman and Hall, London, U.K.

Cornish, P.M. (1980). Water quality studies in New South Wales State Forests. 2. A south coast forest of mixed eucalypts near Bega. Aust. For. 44: 109-117.

Cornish, P.M. (1997). Water yields in the Wallagaraugh River Catchment: A preliminary assessment of forestry impacts. State Forests of New South Wales Internal Report. 7 pp.

Cornish, P.M. and Binns, D. (1987). Streamwater quality following logging and wildfire in a dry sclerophyll forest in southeastern Australia. For. Ecol. Manage. 22: 1-28.

Dignan, P., Murphy, S., Cherry, K. and Rab, A. (1996). Evaluation of Santiago Declaration (Montreal Process) Indicators of Sustainability for Australian Commercial Forests. A Victorian Montane Forest as a Case Study. Forest and Wood Products Research and Development Corporation, Technical Publication No 2. 52 pp.

Dyck, W.J. and Mees, C.A. (Eds) (1991). Long-term field trials to assess environmental impacts of harvesting. New Zealand Forest Research Bulletin No. 161. 215 pp.

Faunt, K. (1995). Research Division's eucalypt plantation database: A review. State Forests of NSW Internal Report. 44 pp.

Gippel, C. (1994). Monitoring turbidity of stream water. Aust. J. Soil Water Conservation 7: 37 – 4?.

Grant, J.C., Laffan, M.D., Hill, R.B. and Neilsen, W.A. (1995). Forest soils of Tasmania. A handbook for identification and management. Forestry Tasmania. 189 pp.

Grayson, R.B., Haydon S.R., Jayasuriya, M.D.A. and Finlayson, B.L. (1993). Water quality in mountain ash forests - separating the impact of roads from those of logging operations. J. Hydrology 150: 459-480.

Green, R., Harris, S. and Throsby, D. (1991). Ecologically Sustainable Development Working Groups. Draft Report - Ecologically Sustainable Forest Use. AGPS 144 pp. (Check if update).

Hamblin, A. (1991). Sustainability: Physical and biological considerations for Australian environments. Working Paper No. WP/19/89. BRR, DPIE, Canberra.

Hart, B.T. and McKelvie, I.D. (19). Chemical limnology in Australia. p. 3-32. In (Eds. P. de Deckker and W.D. Williams) Limnology in Australia., CSIRO, Melbourne. 671 pp.

Hopmans, P., Flinn, D.W. and Farrell, P.W. (1987). Nutrient dynamics of forested catchments in southeastern Australia and changes in water quality and nutrient exports following clearing. For. Ecol. Manage. 20: 209-231.

Hopmans, P.J., Stewart, H.T.L. and Flinn, D.W. (1993). Impact of harvesting on nutrients in a eucalypt ecosystem in southeastern Australia. For. Ecol. Manage. 59: 29-51.

Horne, R. and Carter, P. (1992). Sustained yield, stand structure and non-wood options after 110 years of logging in a New South Wales blackbutt forest. Aust. For. 55: 96-106.

Huntley, B.J. (1991). A sustainable biosphere: the global imperative. Ecology International 1991: 20.

Incerti, M., Clinnick, P.F. and Willatt, S.T. (1987). Changes in the physical properties of soil following logging. Aust. For. Res. 17: 91-98.

JANIS (Joint ANZECC-MCFFA National Forest Policy Statement Implementation Sub-committee). Technical Working Group on Forest Use and Management. (1995). The development of consistent nation-wide baseline environmental standards for native forests. (draft report).

Kavanagh, R.P. and Lambert, M.J. (1990). Food selection by the Greater Glider, Petauroides volans: Is foliar nitrogen a determinant of habitat quality? Aust. Wildl. Res. 17: 285-299.

Kelly, J. and Turner, J. (1978). Soil nutrient-vegetation relationships in the Eden area, N.S.W.:1. Soil nutrient survey. Aust. For. 39: 127-134.

Lacey, S.T. (1993). Soil deformation and erosion in forestry. Forestry Commission of New South Wales Technical Report. 62 pp.

Lane, P.N.J. and Mackay, S.M. (1997). The effect of logging on streamflow in the Tantawanglo research catchments. (Unpublished report for State Forests of NSW).

Likens, G.E. (Eds) (1989). Long-term studies in ecology: approaches and alternatives. Springer Verlag, New York.

Likens, G.E., Bormann, R.S., Pierce, R.S., Eaton, J.S. and Johnson, N.M. (1977). Biogeochemistry of a forested ecosystem. Springer Verlag, New York. 146 pp.

Lubchenco, J., Olson, A.M., Brubaker, L.B., Carpenter, S.R., Holland, M.M., Hubbell, S.P., Levin, S.A., MacMahon, J.A., Matson, P.A., Melillo, J.M., Mooney,H.A., Peterson, C.H., Pulliam, H.R., Real, L.A., Regal,P.J. and Risser, P.G. (1991). The sustainable biosphere initiative: An ecological research agenda. Ecology 72: 371- 412.

Lutze, M. and Campbell, R. (1997). Evaluation of Santiago Declaration (Montreal Process) Indicators of sustainability for Australian Commercial forests. East Gippsland Forests as case study. Centre for Tree Technology, Melbourne (In press).

McLennan, W. (1996). Australians and the Environment. ABS. Canberra. 415 pp.

MacDonald, L. H. (1994). Developing a monitoring project. J. Soil Water Conservation. *:221-227.

Mackay, S.M. and Robinson, G. (1987). Effects of wildfire and logging on streamwater chemistry and cations export of small forested catchments in southeastern New South Wales, Australia. Hydrol. Proc. 1: 359-384.

National Rivers Authority. (1994). The quality of rivers and canals in England and Wales (1990 to 1992). Water Quality Series No 19. AP13 Process Print Ltd, England.

O'Connell, A.M. and Grove, T.S. (1996). Biomass production, nutrient uptake and nutrient cycling in the Jarrah (Eucalyptus marginata) and Karri (Eucalyptus diverscolor) forests of south-western Australia. p. 155-191. In (Eds. P.M. Attiwill and M.A. Adams) Nutrition of Eucalypts. CSIRO, Melbourne. 440 pp.

Powers, R.F. (1989). etrospective studies in perspective: strengths and weaknesses. P 47-62. In (Eds. W.J. Dyck and C.A. Mees). Research strategies for long-term site productivity. IEA/BE A3. Report No.8. NZFRI Bull. 152.

Reid, L.M. and Dunne T. (1984). Sediment production from forest road surfaces. Water Resources Research 20: 1753-1761.

Richards, B.N., Bridges, R.G., Curtin, R.A., Nix, H.A., Shepherd, K.R., and Turner, J. (1990). Biological conservation of the south-east forests. Report of Joint Scientific Committee, Commonwealth of Australia, 407 pp.

Ryan, P.J. (1993). Soil formation on the Wallagaraugh Adamellite, southeastern NSW, Australia. Catena 20: 543-561.

Ryan, P.J., Williams, R.D. and Mackay, S.M. (1989). Tantawangalo research catchments. 1. Soil variablity in relation to terrain. Forestry Commission of New South Wales Technical Paper No. 48. 22 pp.

Spooner, J. and Line, D.E. (1993). Effective monitoring strategies for demonstrating water quality changes from nonpoint source controls on a watershed scale. Water Sci. Tech. 28: 143-148.

Stanton, R. (1992). Eucalyptus plantations in New South Wales. Forestry Commission of New South Wales Research Paper No. 15.

Stewart, H.T.L., Hopmans, P., Flinn, D.W. and Croatto, G. (1990). Harvesting effects n phosphorus availability in a mixed eucalypt ecosystem in southeastern Australia. For. Ecol. Manage 36: 149-162.

Turner, J. (1993). Research and ecologically sustainable Forest management - A discussion paper. State Forests of New South Wales Technical Paper No. 61. 26 pp.

Turner, J. (1996). Evaluation of Santiago Declaration (Montreal Process) indicators of sustainability for Australian Commercial Forests. A New South Wales Alpine Ash Forest as a Case Study. Forest and Wood Products Research and Development Corporation. Technical Publication No. 3. 113 pp.

Turner, J., Kelly, J. and Newman, L.A. (1978). Soil nutrient-vegetation relationships in the Eden area, N.S.W. II. Vegetation-soil asociations. Aust. For. 41: 223-231.

Turner, J. and Lambert, M.J. (1996). Nutrient cycling and forest management. p. 229-248. In (Eds. P.M. Attiwill and M.A. Adams). Nutrition of Eucalypts. CSIRO, Melbourne. 440 pp.

Turner, J., Lambert, M.J. and Dawson, J. (1996). Water quality monitoring strategies for forest management: A case study in the Towamba valley catchment. State Forests of New South Wales Research Paper No. 31. 32 pp.

Turner, J., Lambert, M.J. and Holmes, G.I. (1992). Nutrient cycling in forest catchments in southeastern New South Wales.. 1. Biomass accumulation. For. Ecol. Manage. 55: 135-148.

Turner, J. and Lambert. M. J. (1986). Effects of forest harvesting nutrient removals on soil nutrient reserves. Oecologia 70: 140-148.

Turner, J., Lauck, V., Dawson, J. and Lambert, M. (1996). Water quality monitoring strategies for forest management: a case study at Bago State Forest. State Forests of New South Wales Technical Paper No. 30. 25 pp.

Turner, J. and Pribble, J. (1996). Evaluation of Santiago Declaration (Montreal Process) indicators of Sustainability for Australian Commercial Forests. Forest and Wood Products Research and Development Corporation Technical Publication. No 1. 81 pp.

United Nations (1992). Agenda 21: the United Nations programme of actions from Rio. United Nations, New York, USA.

United Nations (1995). Santiago Declaration. United Nations Secretariat, April.

Walker, J. and Reuter, D.J. (1996). Indicators of catchment health, a technical perspective. CSIRO, Melbourne. 174 pp.

Webster, H.H. (1993). Some thoughts on sustainable development as a concept, and as applied to forests. The Forestry Chronicle 69: 531 - 534.

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Ludwig, J, Tongway, D, Freudenberger, D, Noble, J, Hodgkinson, K. (1997). Landscape Ecology. Function and Management: Principles from Australia's Rangelands. CSIRO. Melbourne.

Tongway, DJ, & Hindley, NL, (1995). Manual for the assessment of soil condition of tropical grasslands. CSIRO Division of Wildlife & Ecology, Canberra.

To be completed]

APPENDIX 9
Summary of Biodiversity Indicators From the State of the Environment Report

Indicators proposed in the State of the Environment report assessed against the criteria specified for indicators in the Eden Regional Forest Agreement (see Section 0). Numbering in left column is from State of the Environment report. Criteria 1-7 refer to: 1 - Linked to criteria; 2 - Scientific basis; 3 - Clearly understandable and interpretable; 4 - Able to measure change; 5 - Cost effective; 6 - Feasible at relevant scales; 7 - Provides early warning of potential problems; 8 - Aggregative.

INDICATOR	**CRITERIA**							
	1	2	3	4	5	6	7	8
INDICATORS ADDRESSED UNDER ECOSYSTEM HEALTH AND VITALITY								
Rate of extension and abundance of exotic species into each IBRA	Y	Y	Y	?	N			Y
Pest numbers	?	?	Y	Y	N			Y
Areal extent of altered fire regimes	Y	Y	Y	Y	?			Y
RELEVANT AND ADDRESSED BY ONE OR MORE OF THE INDICATORS RECOMMENDED FOR EDEN (IN SOME CASES THE INDICATOR HERE RELATES TO A PRESSURE, WHILE THE INDICATOR RECOMMENDED FOR EDEN MEASURES THE EFFECT OF THAT PRESSURE)								
Human population distribution and density	Y	Y	Y	Y	Y			Y
Change in human population density	Y	Y	Y	Y	Y			Y
Human demand on natural resources	Y	Y	?	?	?			?
Pollution	Y	Y	Y	Y	?			?
Extent and rate of clearing or major modification of natural vegetation or marine habitat	Y	Y	Y	Y	Y			Y
Location and configuration or fragmentation of remnant vegetation or marine habitat	Y	Y	Y	Y	Y			Y
Population size, numbers and physical isolation	Y	Y	Y	Y	Y			N
Conservation status of species	Y	N	Y	Y	Y			Y
Percentage of species changing in distribution	Y	Y	Y	Y	N			N
Number, distribution and abundance of migratory species	Y	Y	Y	Y	?			N
Demographic characteristics of target taxa	Y	Y	Y	Y	N			N
Ecosystem diversity	Y	Y	N	Y	Y			Y
Number and extent of ecological communities of high conservation potential	Y	Y	?	Y	?			Y
Extent of vegetation type, marine habitat type in protected areas	Y	Y	Y	Y	Y			?
Proportion of bioregions covered by biological surveys	Y	Y	Y	Y	Y			N
The number of recovery plans	Y	Y	Y	Y	Y			N
Area of clearing officially permitted	Y	Y	Y	Y	Y			N
Area cleared to area revegetated	Y	?	Y	Y	?			N
Reducing the impacts of altered fire regimes	Y	?	Y	Y	N			N
Number of local governments with management plans for biological diversity	Y	Y	Y	Y	N			N
Number of companies with management plans for biological diversity	Y	?	Y	Y	N			N
RELEVANT FOR CONSIDERATION IN FUTURE REFINEMENT AND DEVELOPMENT OF INDICATORS FOR EDEN								
Distribution and abundance of genetically modified organisms	Y	?	?	?	N			?

INDICATOR	**CRITERIA**							
	1	2	3	4	5	6	7	8
Human induced climate change	Y	?	Y	?	?			Y
Environment amplitude of populations	Y	Y	N	Y	Y			N
Genetic diversity at marker loci	Y	Y	N	Y	?			Y
Number of management plans for exotic/alien/genetically modified organisms	Y	Y	Y	Y	Y			N
Control over impacts of pollution	Y	Y	Y	Y	N			N
Minimising the potential impacts of human induced climate change on biological diversity	Y	Y	Y	Y	N			N
Estimated number of species	Y	N	Y	Y	N			Y
Number of species formally described	Y	Y	Y	Y	Y			Y
Percentage of number of species described	N	N	Y	Y	N			Y
Number of subspecies as a percentage of species	Y	Y	Y	Y	N			N
Number of endemic species	Y	Y	Y	Y	N			Y
Number of taxonomists per group	Y	Y	Y	Y	?			N
Number of species per taxonomist	Y	Y	Y	Y	?			N
Number of undescribed species per taxonomist	Y	Y	Y	Y	?			N
Number of interest groups involved in protected area planning	N	N	Y	Y	N			N
Number of ex-situ research programs	Y	Y	Y	Y	Y			N
Number of species described per reporting cycle	Y	Y	Y	Y	Y			N
Number of taxonomists involved per reporting cycle	Y	Y	Y	Y	?			N
Amount of funding for taxonomy	Y	?	Y	Y	N			N
Number of research programs into surrogates	Y	Y	N	Y	N			N
Number of research programs into role of biological diversity in ecological processes	Y	Y	?	Y	N			N
Number of long term ecological sites	Y	Y	Y	Y	N			N
Percentage of budgets spent on conservation	Y	?	Y	Y	Y			N
Local government management of biological diversity	Y	?	Y	Y	N			N
Involvement of community groups in conversation	Y	?	Y	Y	N			N
NOT APPLICABLE OR DEALT WITH BY OTHER PARTS OF THE EDEN REGIONAL FOREST AGREEMENT (EG. THE NEED FOR MANAGEMENT PLANS IS DEALT WITH BY THE MANAGEMENT PROCESSES CONSULTANCY)								
Number of protected areas with management plans	Y	Y	Y	Y	Y			N
Lists and numbers of organisms being trafficted and legally exported	Y	Y	Y	Y	Y			?
Number of permits requested and issued for legal collecting or harvesting by venture	Y	Y	Y	Y	Y			?
Proportion of numbers collected over size of reproducing population	Y	Y	Y	Y	N			?
Ratio of bycatch to target species	Y	?	Y	Y	N			?
Number of subspecific taxa	Y	Y	Y	Y	Y			Y
Number of species	Y	Y	Y	Y	Y			Y
Economic importance of species	N	N	Y	Y	?			N
Integrated bioregional planning	Y	Y	Y	Y	Y			N
Resources committed to protected areas	N	N	Y	Y	N			N
The amount of funding for recovery plans	Y	?	Y	Y	Y			N
Number of releases to the wild from ex-situ breeding	Y	Y	Y	Y	Y			N
Number of management plans for ecologically sustainable harvesting	Y	Y	Y	Y	Y			N
Effectiveness of bycatch controls	Y	Y	N	Y	?			N
Number of lending institutions considering biological diversity	Y	?	Y	Y	Y			N
Number of research programs for exotic/alien/ genetically modified organisms	Y	Y	Y	Y	Y			N

INDICATOR	CRITERIA							
	1	2	3	4	5	6	7	8
Amount of funding for research and control of exotic/alien/ genetically modified organisms	Y	?	Y	?	N			N
Australia's international role in conservation	Y	?	Y	Y	N			N

Concerns expressed and biodiversity values identified by stakeholders at Regional Forest Forum workshops or via written submissions. Right hand column lists the indicator recommended in Section 0 that addresses the concern.

CONCERN/ VALUE	ADDRESSED IN INDICATOR NO:
Integrated biological database - reporting all tenures	
Information on sustainability	
How well are the forests managed?	
Definition of forest management objectives	
Integration across all land tenures to meet objectives - biodiversity, fires, ferals, weeds	
Effective recovery strategies (eg. koalas)	
Refine harvesting methods to result in amore structurally and biologically diverse forest	
Money for studies	
Increased level of knowledge across all land tenures, monitoring of forest	
Maintain/ enhance biodiversity	
Community involvement in ongoing monitoring - baseline information necessary	
Repository for Australia's evolutionary history	
Adequate reserves	
Ability for disturbed forest to recover	
JANIS criteria upheld	
Long term scientific research - all tenures	
Reserve system and management for conservation objectives seen as complementary	
Forest management objective driven	
Reporting against objectives	
Pick up both on reserve values and values protected off reserves	
Species diversity	
Intensive conservation surveys over next five years	
Monitor impacts of windshear (on habitat trees), especially the affect of logging practices	
Need for silvicultural strategies to allow replacement of older growth stages	
Full application of JANIS criteria	
Special attention to old growth (protection of all remaining stands)	
Use Montreal indicators of ecosystem diversity (a) to (e) to assess how well JANIS targets have been met	
Monitor Montreal indicators of species diversity (a) and (b) - Conservation of viable populations of all threatened species in the region	
Monitor populations of representative common species as surrogates for rare species	
Monitor plant species diversity as a cost-effective indicator of biodiversity - no reduction over a full rotation	
Number of hollow-bearing trees as an indicator	
Concern for long-footed potoroos and koalas	
Concern about regeneration of appropriate species after logging	
Concern about yellow-bellied gliders as an example of species that require specific landscape scale pattern and large areas of intact forest	
Long term recruitment of adequate numbers and types of hollow-bearing trees in the logging	

CONCERN/ VALUE	**ADDRESSED IN INDICATOR NO:**
mosaic	
Suggested indicator: Extent of production forest managed to sustain occurrence of species indigenous to production site	

APPENDIX 10
Issues from Workshop on ESFM indicators For Criterion 2: Productive Capacity and Criterion 4: Soil and Water

Issue	Indicator addressed in present paper
What we would like to see in forest management now	
Adequate and ongoing research and monitoring	2.8, 4.7
Information on sustainability	
Timber – sustainable yield	2.5
Nutrient budgets	4.2, 4.6
Water	4.3, 4.4,,4.5
Soils	4.1, 4.2
Structure/age	2.2, 2.3
Better utilization of plantations	
What we would like to see in forest management in 5 years	
Money for studies	2.8, 4.7
Increased level of knowledge across all land tenures	2.1, 2.2, 2.3, 2.4, 2.5
Maintain/enhance soil and water quality	4.1, 4.2, 4.3, 4.4, 4.5
What we would like to see in forest management in 5-15 years	
Ecologically sustainable viable yield	2.5
Economic hardwood plantations expanded	2.4
Viable pulp industry	not addressed
Comprehensive reporting mechanism on how we are going	not addressed
Sustainable yield provision for stable industry	2.5
What we would like to see in 20 years.	
Achieve international accreditation	not addressed
More specialised knowledge	2.8, 4.7
Timber industry based on regrowth forests and plantations	not addressed
Maintenance of water values (quantity and quality)	4.3, 4.4, 4.5

APPENDIX 11
Summary of Indicators from the State of the Environment Report (Hamblin 1997)

Selected indicators* proposed in the State of the Environment report on Land Resources (Hamblin 1997) assessed (by us) against the criteria for indicators given in our brief. Criteria 1-7 refer to: 1 - Linked to criteria; 2 - Scientific basis; 3 - Clearly understandable and interpretable; 4 - Able to measure change; 5 - Cost effective; 6 - Feasible at relevant scales; 7 - Provides early warning of potential problems; 8 - Able to be aggregated with other indicators to assess Ecologically Sustainable Forest Management.

Note: The State of the Environment report lists a large number of indicators of accelerated erosion, physical changes to natural habitats, hydrological imbalance, nutrient and salt recycling and soil and land pollution, which are dealt with under various criteria under the Montreal scheme. Therefore, we have only listed here the indicators that we consider will not be covered under other Montreal criteria or which are useful aggregations of other indicators that are relevant to our working definition of Ecosystem Health and Vitality.

INDICATOR	**CRITERIA**							
	1	2	3	4	5	6	7	8
Percent forest areas cut to environmental guidelines	Y	Y	Y	Y	Y	Y	Y	Y
Rate and extension of exotic species	Y	Y	Y	Y	Y	?	Y	Y
No. of reports of weeds, pests etc.	Y	Y	Y	?	Y	Y	Y	Y
Percent land with fast changing exotic biota	Y	Y	N	?	?	?	N	Y
Weed infestation index	Y	Y	?	Y	?	?	Y	Y
Control of pests	Y	Y	Y	?	?	?	N	Y
Total immobile contaminant load per land area	Y	Y	?	?	?	?	Y	Y
Dollar value of pesticides sold by land use	Y	Y	Y	?	Y	Y	Y	Y
Rate of pesticide onset in target spp.	Y	Y	?	?	?	?	Y	Y
Status of known highly contaminated sites	Y	Y	?	?	?	?	Y	?
Area of pesticide application	Y	Y	N	Y	?	?	Y	Y
Reduction in land pollutants	Y	Y	N	?	?	?	Y	Y
Progress to national registry of pesticides used	Y	N	N	Y	Y	Y	N	Y
Implementation of risk reduction protocols	Y	Y	Y	Y	Y	Y	N	Y

Indicators proposed in the Montreal process workshop on Ecosystem health and Vitality held in Canberra in July 1997 ([*insert reference] assessed (by us) against the criteria specified in our brief. Criteria 1-7 refer to: 1 - Linked to criteria; 2 - Scientific basis; 3 - Clearly understandable and interpretable; 4 - Able to measure change; 5 - Cost effective; 6 - Feasible at relevant scales; 7 - Provides early warning of potential problems; 8 - Able to be aggregated with other indicators to assess Ecologically Sustainable Forest Management.

INDICATOR	CRITERIA							
	1	2	3	4	5	6	7	8
Area percent of forest affected by processes or agents beyond the range of historic variation	Y	Y	?	Y	Y	Y	Y	Y
Area and percent of forest land subjected to levels of specific air pollutants (eg. sulphates, nitrates, ozone) or ultraviolet B that may cause negative impacts on the forest ecosystem	Y	?	N	?	N	N	?	?
Area and percent of forest land with diminished biological components indicative of changes in fundamental ecological processes (eg soil nutrient cycling, seed dispersal, pollination) and/or ecological continuity (monitoring of functionally important species such as fungi, arboreal epiphytes, nematodes, beetles, wasps etc..	Y	Y	Y	Y	Y	Y	Y	Y
Measurement of rates of change in the key threatening processes, related to our [improved] understanding of the processes or of measures to quantify amelioration or exacerbation of the processes	Y	Y	?	?	?	?	?	Y
Area and percent of plantations formally surveyed for health status and proportion damaged	Y	Y	Y	Y	Y	Y	?	Y

APPENDIX 12
Summary of Stakeholder Concerns and Inputs

See documents prepared by stakeholders and outcomes of Tuesday's meeting; turn into a table)

- Representation of forest types in secure tenures (JANIS as minimum target)
- Protection of all remaining old growth
- Monitoring of rare and endangered species; viable populations
- Hollow bearing trees
- No loss of plant species diversity

Concerns expressed and values identified by stakeholders at Regional Forest Forum workshops or via written submissions. Right hand column lists the indicator recommended in Section 0 that addresses the concern.

CONCERN/ VALUE	**ADDRESSED IN INDICATOR NO:**
How well are the forests managed?	3.2
Definition of forest management objectives	3.2, 3.5
Integration across all land tenures to meet objectives - biodiversity, fires, ferals, weeds	3.2, 3.5
Community involvement in ongoing monitoring - baseline information necessary	3.2
Attention to fires, ferals, weeds	3.1, 3.2
Monitor loss and damage to regrowth and sawlogs from wildfire and prescribed burning	3.1, 3.2, 3.4
Bell minor/ psyllid dieback	3.1, 3.2
Monitor impacts of pests on all land tenures, especially reserved old growth	3.1, 3.2
Monitor prevalence of feral vertebrates	3.1, 3.2