Forest Conservation Fund

Conservation Value Index Technical Report

Assessment Methodology Advisory Panel

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Acknowledgements

The Assessment Methodology Advisory Panel developed this technical paper. The panel membership includes two ecologists, Dr Philip Barker (team leader) and Dr Michael Brown, three economists, with experience in market based instruments relating to the purchase of ecological assets and services, Mark Eigenraam, Dr Michael Burton and Dr Stewart Whitten. Rod Knight undertook data analysis and management and contributed significantly to the development of the CVI. The Commonwealth and Tasmanian governments have had input into development, through responses to presentations and drafts. In particular, Steve Cork, Katy Mallet, Simon Nash, and Salim Mazouz have contributed in this way.

Table of Contents

Executive Summary 1

1. INTRODUCTION 2

1.1. FCF OBJECTIVES AND AMAP TERMS OF REFERENCE 2
1.2. CONSTRAINTS: 4
1.3. CVI OBJECTIVES 5

2. SIGNIFICANCE 7

2.1. FOREST PRIORITY CLASSES 7

3. FOREST HEALTH AND ELIGIBILITY 12

4. FOREST PRIORITY SCORE MODIFIERS 13

4.1. RESERVATION STATUS 13
4.2. MODIFIER 1. STRUCTURAL CONDITION (STC) 14
4.3. MODIFIER 2. CURRENT CONDITION VALUE (CCV) 16
4.3.1 Measurement of the elements of Current Condition Value 16
4.3.2 Calculation of Observed Condition 21
4.4. MODIFIER 3. THE REGIONAL THREAT INDEX (RTI) 23
4.4.1 Calculation of the RTI 25

5. FOREST SERVICES 28

5.1. MAINTENANCE (M) 29
5.2. IMPROVEMENT (I) 30
5.3. SECURITY 30

6. REFERENCES 33

APPENDIX I. ANALYSTICAL ASSESSMENT OF CVI 35

APPENDIX II. FORESTS IN EACH FOREST PRIORITY CLASS AND SUMMARY INFORMATION 37

APPENDIX III. FOREST SUSCEPTIBILITY TO THREATS 38

APPENDIX IV. WEEDS CONSIDERED FOR POTENTIAL IMPACT 42

APPENDIX V. MAPS OF THE REGIONAL THREAT INDEX. 48

MAP 1. COMBINED RTI SCORES 48
MAP 2. *PHYTOPHTHORA CINNAMOMI* SUSCEPTIBILITY 49
MAP 3. WEED RISK 50
MAP 4. GRAZING RISK 51

EXECUTIVE SUMMARY

The following approach to measure the conservation value of proposals provided to the FCF is based on the objectives of the FCF Strategic Plan. The FCF AMAP Options Paper (January 2006) proposed an assessment method that would incorporate three elements:

- **Significance**: The significance of a proposal describes the contribution forest makes to the CAR reserve system in terms of the priority assigned by the FCF program and its current condition. The priorities reflect those of the RFA and have been calculated using the JANIS criteria for threat and reservation targets.
- **Service**: This element aims to estimate the ecological service a forest provides. The current condition of a forest determines its capacity to provide such services. The current condition of the forest is assessed from two perspectives, past landholder actions that have resulted existing conditions, and the degree to which future landholder actions can improve the condition of the forest.
- **Security**: The level and duration of the management agreement offered by the proposal.

The Conservation Value Index (CVI) scores a proposal for each attribute contributing to significance, services and security. The CVI is the aggregate of significance, service and security. The higher the index the more highly valued the site. The CVI aggregation method is described in this report.

The development of the metric was informed by its need to be applied in a tender mechanism. However the final application of the metric is independent of the tender process and as such can be used in tandem with any market mechanism, or indeed to measure the relative effectiveness of any policy option aimed at the management of forested areas.

The following equations show the abbreviated and full forms of the CVI equation:

Abbreviated form:

$$CVI = \left[FPS - \left(\tfrac{1}{3} FPS_{D2} * StC\right) - \left(\tfrac{1}{3} FPS_{D2} * CCV\right) - \left(\tfrac{1}{3} FPS_{D2} * RTI\right) + \left(FPS_{D1} * RES\right)\right] * \left(M + I\right) * S$$

where, $\{StC, CCV, RTI, RES\} = (1,\ldots,0)$

Full form:

$$CVI = \left[FPS - \left(\tfrac{1}{3} FPS_{D2} * (1 - StC/50)\right) - \left(\tfrac{1}{3} FPS_{D2} * OC/100\right) - \left(\tfrac{1}{3} FPS_{D2} * RTI/100\right) + \left(FPS_{D1} * (1 - RES/100)\right)\right] * \left(M + I\right) * S$$

The following sections provide detail on each of the elements in the CVI.

The CVI represents a pragmatic trade-off in developing a systematic, robust and repeatable method for differentiating between the values offered by alternative offers to the FCF. The method is based on expert judgements between the attributes representing value to the FCF (as described through significance, service and security) and is limited by the availability of data. The CVI incorporates several pragmatic tradeoffs designed to make field assessment robust, repeatable, tractable and time effective but also ensure appropriate discrimination between alternative proposals.

Note: the accompanying spread sheet does not include the influence of security. It has been proposed that security may be a multiplicative weight of 1 for a twelve year contract and 5 for a perpetual covenant.

Where:

Significance of forest type (FPS, FPS_D)

FPS *Forest Priority Score*

The forest priority score (FPS) reflects the relative preference the CVI places on each of the forest types. The FPS can be informed by the preferences of those providing funds and or ecological criteria (FCF primary objectives, progress toward JANIS reservation targets, condition etc.).

The objectives of the FCF Strategic Plan (FCPSP) are to protect 45,000 hectares of forested private land with a minimum of 25,000 hectares of old growth forest. (p 3). Also it says to take into account under reserved status on a state-wide or bioregional basis including all communities classified as rare and endangered……(p. 30). "Presence of OG forest communities" (p 30)

The FPS ranges between 10 and 100 for 12 forest priority classes "to reflect the FCF objectives for the protection of old growth forest and under reserved (non-old growth) forest communities." (Table 1, p.2).

Forest priority score distance

Type	Rank	FPS	Distance
OG	1	100	6
OG	2	94	6
OG	3	88	6
OG	4	82	6
OG	5	76	6
OG	6	70	10
OG	7	60	15
Non-OG	8	45	6
Non-OG	9	39	6
Non-OG	10	33	6
Non-OG	11	27	17
Non-OG	12	10	

FPS_{D2}

FPS_{D2} is used to adjust the preferences for forest types based on structural condition, current condition and regional threat.

This is the sum of the distance between 2 forest classifications (D2). For instance the FPS_{D2} for type 1 forest is the bottom of type 2 (or top of type 3) which is 6 + 6 = 12, or between type 6 and bottom of type 7 is 10 + 15 = 25.

Thus the aggregate impact of structural condition, current condition and regional threat for each forest type is limited to two FPS classes by FPS_{D2}

FPS_{D1}

FPS_{D1} is used to adjust the preferences for forest types based on rarity.

This is the distance between two forest classifications. For instance the FPS_{D1} for type 1 and type 2 is 6, or between type 6 and type 7 is 10.

Thus the impact of rarity within forest types is limited to the range within each class by FPS_{D1}

Structural condition (StC)

StC *Structural Condition*

Seeks to capture the structural form of the forest and is derived from the RFA Forest Resource Type assessment (**Section 2.2.2, p4**). Forests with mature structural characteristics are becoming rarer and hence more important for conservation.

This approach has been adopted because it differentiates the forest types into structural forms that more closely reflect FCFSP preferences (condition as noted on **page 30**) and the level of disturbance which is an important ecological criterion for the support of flora and fauna.

The *StC* score ranges between 0 and 50 for non-old growth and between 40 and 50 for old growth (50 representing lowest disturbance and lower numbers increasing disturbance or shorter time since disturbance **Table 2, p5**).

Structural condition score OG and non OG

Type	Rank	Score
OG Good	0	50
	1	48
	2	46
	3	44
	4	42
OG Bad	5	40
Non-OG Good	0	50
	1	40
	2	30
	3	20
	4	10
Non-OG Bad	5	0

Current Condition of forest type (CCV)

CCV *Current Condition Value (0 – 100)*

BCV – Observed Condition

Observed Condition – ranges from 0 (very good, no observed impacts) to 100 (very bad, maximum impacts). It is assumed best condition for all types is 100 which reflects the *BCV* (Benchmark Condition Value) of each forest type. It represents a normalised view of the undisturbed natural condition of forest types set at 100 (Section 2.2.1 , p4).

The FPS of each forest type is modified down based on the current condition of the forest. For instance, forest type A may be preferred over B but as the quality of a patch of A falls, the preference for A falls, until it is on an equal basis as B (subject to the limits noted above). This takes into account the ecological viability and the level of threat the forest is under (p30) (note page 30 says "to be considered suitable for reservation, forest sites…..)

Regional Threat Index (RTI)

RTI A measure of surrounding threat which includes: *Phytophthora cinnamomi (root rot)*, weeds and grazing.

The RTI reflects how susceptible forests are to further losses in condition based on their context within the landscape.

The preferences of the FCFSP state that the area should contribute to ecological viability in the long term (p. 30). RTI contributes to this aim because a forest that is currently in good condition in a low threat landscape has a higher probability of staying in good condition because less effort is required to protect from surrounding threats. . This is because fewer threats are present and the corresponding effort required maintaining the forest will be less than that required in a high threat landscape.

The RTI also captures some of the risk associated with investing in natural resource outcomes. A site that is under high threat is a higher investment risk when assessing the future likelihood that the forest will still be in good condition. Government is interested in minimising its investment risk for a given budget This is particularly important for perpetual agreements where long-term monitoring may be weak.

NB: This has important implications for the contract because it needs to contain a minimum set of actions for the maintenance of a forest in its current condition, ie no further decline due to weeds, grazing and PC. If these requirements are sufficiently strong and well enforced, RTI may only be necessary for threats that can not be managed (such as some aspects of *Phytophthora cinnamomi* spread) because by definition other threats are managed within the contract.

Note: The sum of the impacts of StC, CCV and RTI on the Forest Priority score are limited to a maximum loss equal to two forest priority classes. The potential

individual impact of each of StC, CCV and RTI is equal and is two thirds of one priority class.

Reservation (RES)

RES Reservation

RES= min FPS_{D1}, FPS_{D2} *loss* (*1-RES/100*)

The aim of reservation is to reflect the current reserved area of a forest relative to a target reservation area. If current area is a long way from the target the forest type is preferred over one closer to target.

The choice of target is then very important to determine reservation – the CVI is using the JANIS system to define targets. The targets represent the proportion of a forest type that should be protected in the CAR reserve system.

Reservation is a percentage measure of how far away a forest type is from achieving its target reservation area. The reservation measure results in preferencing the CVI towards forest types that are further from their target.

All else equal if there is 5% of target for one forest compared to 90% of target for another we prefer the former. The FPS is adjusted to reflect this reservation status.

Reservation is used to differentiate within a class, not between classes. Therefore the least reserved forest type within a classification can only regain the FPS points within that classification. For instance, class 1 = 6, class 7 = 15.

Maintenance (M)

M Maintenance (0.3 * CCV)

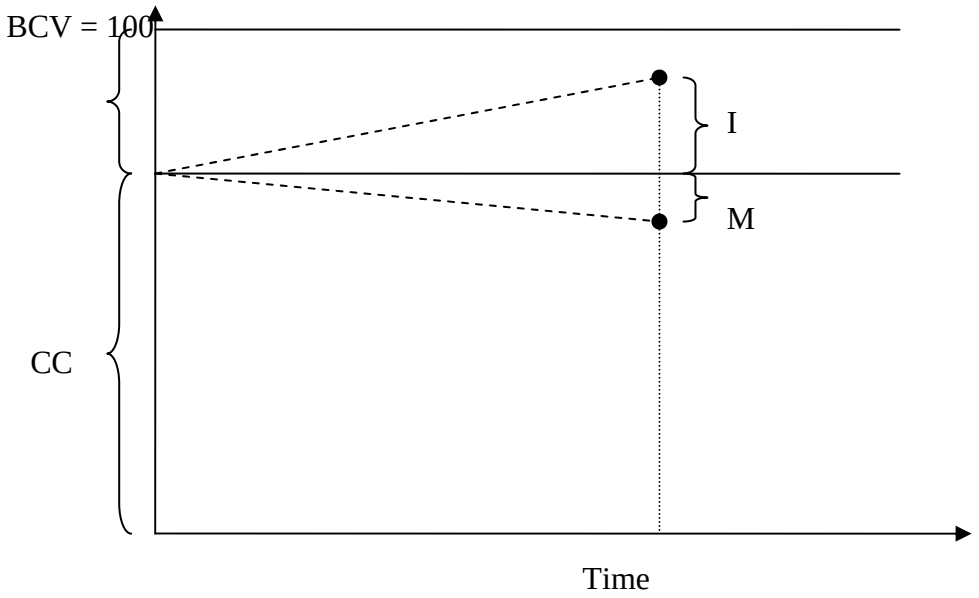
The FCFSP recognises the importance of protecting the future of forested sites. The better the condition of the forest now the more there is to lose in future, therefore an ad valorem amount was considered appropriate. A value of thirty percent of the current condition value (CCV) was seen as reasonable when considered within the context of the score attainable in the improvement element (see below).

Improvement (I)

I Improvement (1- 36)

Landowners are invited to nominate element/s of PC, weeds and stock grazing they intend to manage and the extent they intend to manage it. The magnitude of the change (ie improvement) ranges from 0 to 36 (0 represents no improvement and 36 represents the maximum possible). The score is based on the change in rank of CCV (aggregated impact of PC, weeds and stock grazing) to the intended class.

A schematic depiction of the relationship between benchmark condition (100) observable condition (OC) and current condition value (CCV) and including maintenance and improvement.



Security

S *Security*

Security represents the different values attributed to how long the forest is protected. Two levels of security will be offered. These will be a 12 year contract and a perpetual covenant. The degree of protection within each level will be the same (i.e. the same actions will be prohibited or required). The weights for each of these options have not been finalised. Financial discounting suggests weights up to 5 times for perpetual covenants; politically inspired weights offer an alternative for determining weights and AMAP offers no advice on this.

1. INTRODUCTION

The Forest Conservation Fund is a voluntary program to increase the private land component of the Comprehensive, Adequate and Representative Reserve System for forest communities in Tasmania.

An Assessment Methodology Advisory Panel (AMAP) was set up to develop a system for measuring ecological gain and to design a cost effective delivery mechanism. The primary mechanism for consideration is a market-based tender approach that allows landowners to offer forest for protection at a price that they determine.

The following sections provide an overview of the FCF objectives and the role of AMAP in achieving them followed by ecological criteria that AMAP consider to be important to meet FCF objectives.

1.1. FCF objectives and AMAP Terms of Reference

AMAP have based the development of the CVI on the following guidelines and objectives taken from the Forest Conservation Fund Strategic Plan (FCFSP)[1] and the FCF Steering Committee recommendations from Stage 1 noted above:

- The FCF's objective is to protect up to 45,600[2] hectares of forested private land, targeting old growth forest and under-reserved forest communities, of which there will be a minimum of 25,000 hectares of old growth forest.
- Develop an assessment methodology to assess value for money of a proposal either from a competitive tender, purchase or negotiated agreement. The methodology must take into account conservation and management value, the cost of accepting a proposal relative to other proposals and the Fund's capacity to pay (taking into account total funding available and the area targets that need to be achieved). AMAP are not aware of total funding.
- The CVI should build on existing knowledge and tools[3], be simple, practical and pragmatic and fit in with current knowledge and data in Tasmania.

AMAP completed a Stage 1 report which was submitted to the FCF SC on January 16th 2006. The SC accepted the report and recommended that Stage 2 develop a CVI that contains the following three elements**.**

Conservation Value Index $= f\{Significance, Service, Security\}$

- **Significance**: The significance of a proposal describes the contribution the forests make to the CAR reserve system in terms of the priority assigned by the FCF program, its current condition and progress toward JANIS reservation targets.

[1] The following points have been drawn from the FCFSP 2006 and the AMAP terms of reference.

[2] Note the 45,600 total includes up to 2,400 hectares of forest to protect the karst values in the Mole Creek area. This Mole Creek component is being addressed in a separate Mole Creek programme outside of the FCF.

[3] Specifically the Tasmanian PFRP tools and data sets.

- **Service**: The current condition of the forest and the degree of risk it is subject to due to regional influences (landscape context) is considered in the context of the impact of landholder conservation management actions that would maintain existing values, and the degree to which landholder actions improve the condition of the forests included in their proposal.

  The current condition of the forest dictates the level of service that can be provided.

- **Security**: The level and duration of the management agreement offered by the proposal.

The notes below are the recommendations the Steering Committee (SC) supported from the Stage 1 options paper but do not reflect modifications that were made during development which are described subsequently.

Significance – Option 2

The measure of significance score is based on a scale of forest priorities described in **Error! Reference source not found.**, page 9, below. These reflect the primary factors relating to the objectives of the FCF. The priorities are weighted to promote old growth and then under-reserved communities. Proposals are scored using an area-weighted average of each priority patch of forest.

The priority forest communities occur across a range of altitudes, soils types, climatic regimes and land uses. The method relies on the variety of habitats that are present across the full range of priority forest communities as a surrogate for threatened species habitat. Many threatened species are so threatened because of the past clearance of forest habitat. The forests that represent their habitat are now the rare and endangered forest types that are included in the primary objectives. The remnants of these habitats have a high probability of supporting a suite of commonly associated threatened species.

Significance also incorporates a component for context (connectivity to reserves and patch size in a similar way to both the PFRP Strategic Reserve Design (SRD) and Oliver and Parkes 2003). It takes advantage of existing data in an existing structure that allows the assessment to be run with a minimum of additional development. The risk posed by adjacent threats is also part of the context score. The risks may include grazing, weeds, pests, subdivision, harvest, clearing, mining, and are assessed by for example soil type (productivity) or vegetation type or region. This is a desk top assessment that can fit into the current data structure.

The risks are weighted by a regional average (forest susceptibility) for each risk eg *Phytophthora* is a high risk on poor soils and conversion to plantation is a high risk in the north east and north west on suitable soils and subdivision is a high risk near Hobart.

The field assessment requires confirmation of the extent of old growth, under reserved and RVE communities ie confirmation or field truthing of the RFA (Tasveg) map.

A simplified SRD process is used to generate benchmarks by using a modified reserve building algorithm for a 46 000 ha (25,000 ha old growth) reserve scenario. This index will act as a benchmark against which all proposals can be compared. This will assist in managing the composition of the reserve system, gauging progress and will inform adjustment of the metric as needed (for example, between tender rounds).

Service – Option 2

A modified biophysical naturalness layer (produced during the RFA) is used to report the condition of the forest. The classification uses a high medium and low measure to which numeric scores are given for each threat. This layer scores the condition of the forest in the proposal according to the manageable threats that are present, for example:

1. timber harvesting
2. grazing
3. weeds
4. pests
5. fire
6. Phytophthora
7. potential for subdivision

The scores for threat management and hence improvements in condition are based on changes in the measure of threats 1-7 and hence the overall condition score. Change may be estimated by the predicted impact of proposed actions. Field assessment is required to attribute scores for each threat.

Security – Options 1 + 2

1. Covenant in perpetuity or 12 years plus a management period:
    a. In perpetuity
    b. 12 years
2. Covenant only
    a. In perpetuity.
    b. 12 years

The following section outlines how the above approach has been interpreted by the AMAP in order to develop an approach that is ecologically robust and the ability of a service provider to implement the CVI in Tasmania.

1.2. Constraints:

AMAP have provided advice to DEH on the abundance of forests in each priority class and the associations of oldgrowth forests with other forest types. These data inform DEH on the likely composition of proposals that may be attracted by the FCF. The composition of proposals with regard to old growth content have important implications for progress toward the objectives of the FCF. In response to the advice DEH have clarified specific constraints. These are:

- Adequately reserved old growth is preferred over under reserved rare, vulnerable and endangered communities.
- The condition of a forest should not result in a change in the order of preferences between old growth and under reserved rare, vulnerable or endangered communities.

- Once the old growth objective has been met the preferences may change to reflect the relative abundance and reservation status of each community in a continuous scale and regardless of old growth status.

1.3. CVI objectives

The aim of the CVI is to measure the ecological benefits that can be obtained from landholders *'actively'* managing Tasmanian forests. The CVI will be informed by:

Ecological goods and services (EGS) – forests can provide refuge and habitat for flora and fauna. The better the condition of a forest the more EGS it can provide. Actions undertaken by a landholder that improve the condition of a forest result in the provision of greater EGS. The CVI is designed to interpret the actions landholders take into a change in the level of EGS provided.

Forest preference - the preferences of the purchaser of EGS can be expressed through the forest types. For two forest types providing the same level of EGS the purchaser may prefer one forest type over another. In the case of the FCF program the agency prefers old growth and under reserved forest types.

Contract design – The actions that farmers are contracted to provide must be observable for monitoring and enforcement purposes in order to give the contract credibility. There may be instances were an action is highly desirable from an ecological perspective but cannot be monitored and enforced, trade-offs between optimal actions and contract design need to be considered.

The Tasmanian DPIW has been engaged to monitor contracts. This will include confirming the actions agreed to in the management agreement have been successfully completed. The monitoring effort therefore involves rescoring the observed condition. The monitoring strategy should present a significant probability that any one contract will be monitored in any year.

Data availability – Accessibility to data to inform and support the implementation of the CVI. In order to make an estimate of the ecological goods and services provided as a result of landholder actions requires general and specific data about each of the forest types. This may include information that characterises its natural state, current condition and its context within the landscape.

CAR Reserve System - Encapsulates the themes of comprehensive, adequate and representative examples of ecosystems. The aim of comprehensiveness is to include the full range of regional ecosystems (in this case forests). In order to ensure the maintenance of viable populations, species and ecosystems a sufficient or adequate area needs to be reserved or managed for each forest type. The areas selected for inclusion in the CAR reserve system should reasonably reflect the intrinsic variability of the forest they represent. Currently preferences for the FCF are predicated on either adequately or inadequately reserved OG and NON-OG. This aligns with the PFRP system but it a coarser approach.

Fundamental principal of the CVI is the purchase of services which are then prioritised by the agencies preferences for alternative forest types. Services are good because they reflect the ecological goods and services a forest type provides. It is not possible to simply distinguish between forest types based on preference alone for a forest type may be in very poor condition and unable to provide any EGSs.

The following sections contain detailed descriptions of the formulations for the Significance, Service methodologies and their aggregation in the Conservation Value

Index (CVI), followed by brief discussion of Security. The report presents all of the technical aspects of the assessment method followed by the construction of each term of the metric and finally the aggregation of the terms.

Patch size - The CVI does not incorporate connectivity or patch size of a forest in the CVI. Inclusion of connectivity to reserves and patch size may (will) bias the preference away from forest remnants that are remote from reserves and small patches that are very important remnants, in part due to their remoteness from reserves as well as being the only remaining examples in an area. A patch size distribution analysis of different forest types suggests that what is a small patch for one type is a large one for another. The causes are the proportion of area in small remnants (eg *Eucalyptus ovata* forest) and the natural stand size that occurs in undisturbed mosaics (eg *Eucalyptus rodwayi* along drainage lines versus *E. viminalis* which is extensive). As such the size of a patch of forest in a mosaic of undisturbed forest should not be a selection criterion.

However, a minimum size for a proposal should be considered. If the edge effects of clearance and adjacent land use extend to 100 m inside a forest patch then a four-hectare patch could be consumed by edge effects. We therefore suggest that a minimum of proposal size of 10 ha should be an eligibility criterion.

2. SIGNIFICANCE

The term "significance" describes the preference the FCF have for forest types relative to one another.

Significance is calculated by incorporating the following:

1. The conservation status of the particular type of forest (Forest Priority Class, FPS).
2. The structural condition of the forest (StC, see below) which indicates the growth stage following disturbance.
3. The condition of the forest (see CCV below) with respect to the intensity of the impact of three major threats that reduces the FPS of a forest type.
4. The regional threat context that the forest exists in.
5. The forests progress toward the JANIS reservation criteria.

A forest type can be reduced in significance by a maximum of two FPS classification units. The modification to significance is based on the assumptions that a patch of forest in good condition is more valuable than one in poor condition, a forest under low threat in a landscape context is preferred over one under high threat and a forest with only a small proportion reserved is preferred over one with a large proportion reserved.

Elements included in condition and threat assessment include: *Phytophthora cinnamomi*, weeds and grazing.

The following sections describe the above points in detail.

2.1. Forest Priority Classes

Each forest community is assigned a priority score based on twelve priority classes. The classes are derived from a dichotomous key that reflects the primary objectives of the FCF including consideration of under reserved communities at the state and bioregional scales. This stratification is identified in the strategic plan and is presented schematically in Figure 1. The forest communities in each class are listed in Appendix 2. Appendix 2 also presents summary data of the extent and reservation status of each community and an explanation of the JANIS criteria.

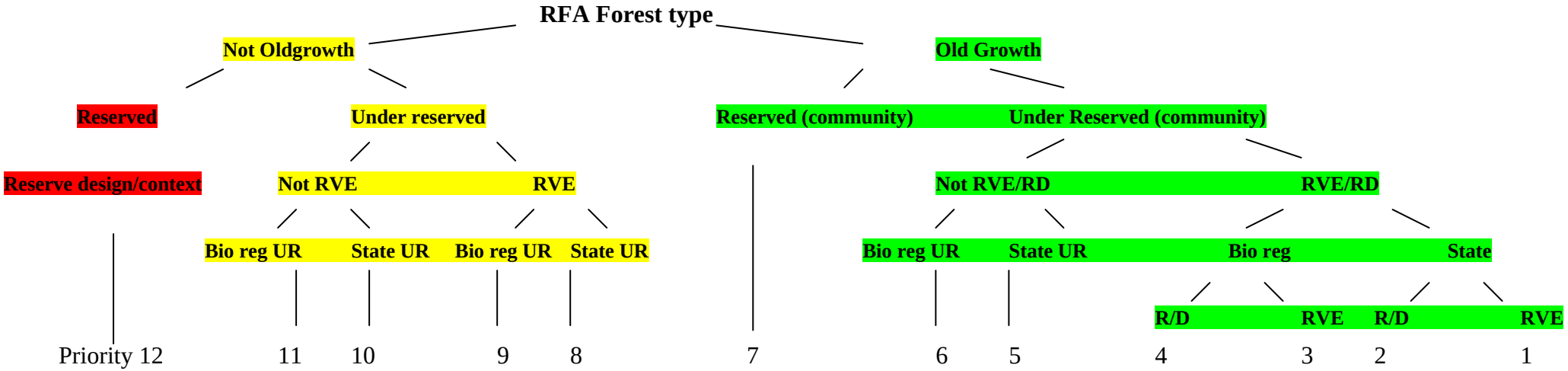
The conservation categories of rare or depleted for old growth and rare, endangered or vulnerable for all forests are derived from the JANIS criteria and the Tasmanian RFA. The level of reservation has been calculated from the most recent reservation analysis[4]. Table 1 lists the scores assigned to each of the 12 priority classes. The scale between classes reflects the relative preference for each priority class. There are two discontinuities in the scale. These act to quarantine under reserved old growth from adequately reserved old growth and all old growth from non old growth after consideration of the condition of the forest. The effect is that all old growth is preferred to non old growth regardless of condition.

[4] Reservation areas include the Tasmanian Community Forest Agreement and PFRP data. An integrated CAR reserve layer is in preparation and will be incorporated when available.

Table 1 Forest priority categories & forest priority scores (FPS)

Priority Category	Forest Descriptor	FPS
1	Old growth of Statewide RVE communities	100
2	Old growth Statewide R/D	94
3	Old growth of Bioregional RVE communities	88
4	Old growth Bioregional R/D	82
5	Inadequately reserved old growth Statewide	76
6	Inadequately reserved old growth Bioregionally	70
7	Adequately reserved old growth	60
8	Under-reserved non-old growth RVE Statewide	45
9	Under-reserved non-old growth RVE Bioregional	39
10	Under-reserved non-old growth Statewide	33
11	Under-reserved non-old growth Bioregional	27
12	Adequately reserved non-old growth	10

Figure 1.The diagram below illustrates the priorities of the forests according to the FCF program objectives.



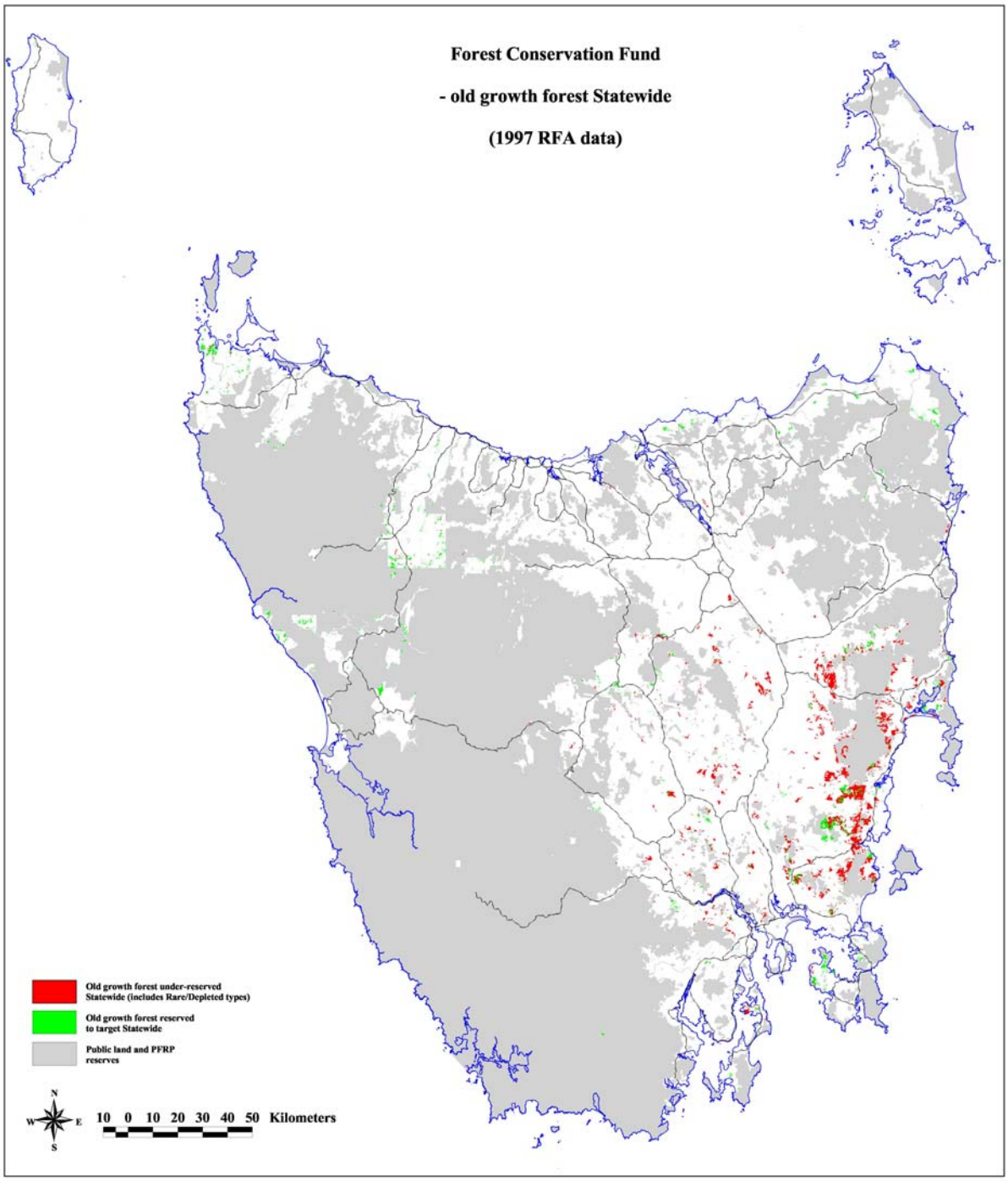


Figure 2. Old growth forest on private land.

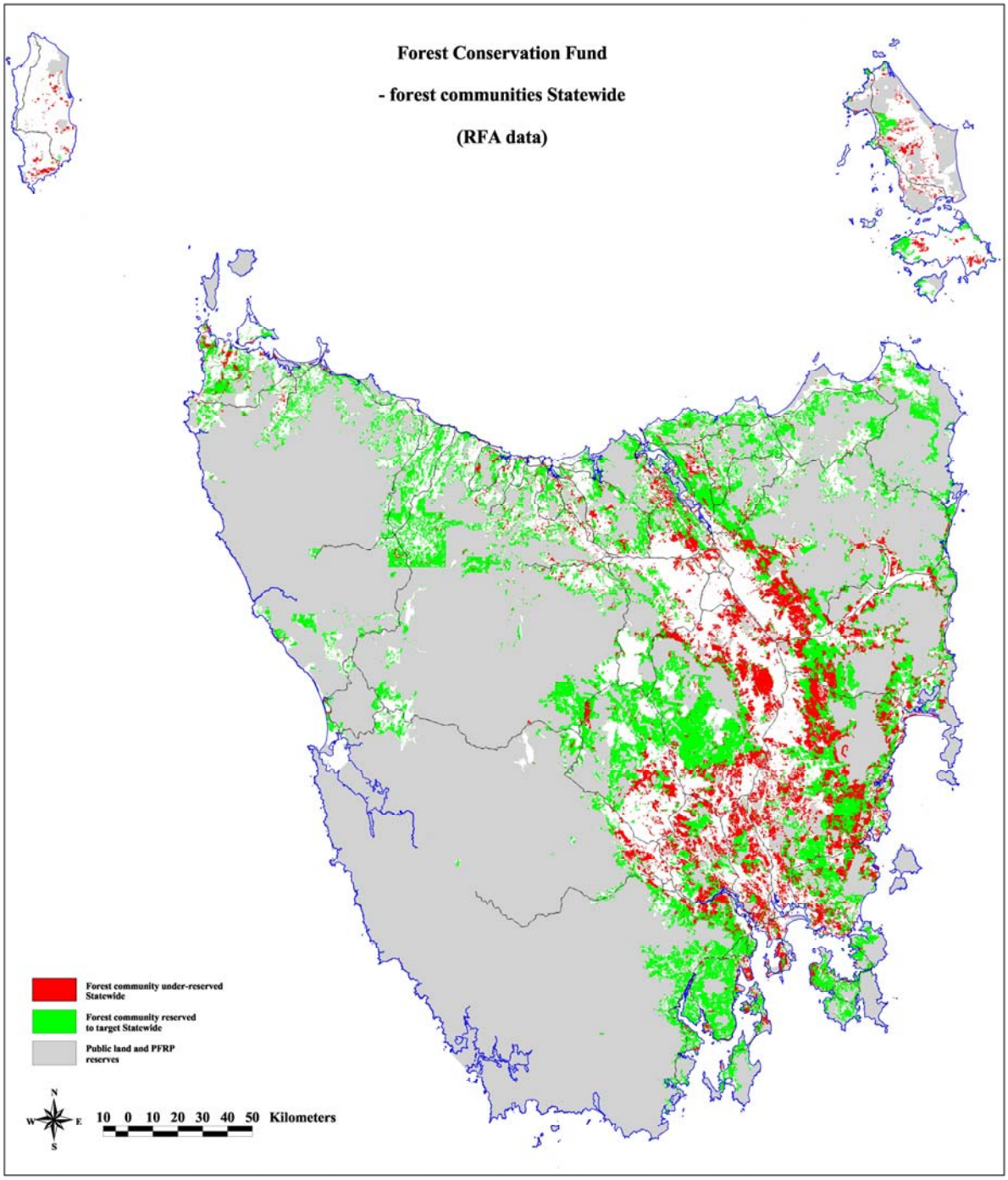


Figure 3. Under reserved forest on private land.

3. FOREST HEALTH AND ELIGIBILITY

Many stands of trees in eastern Tasmania suffer from "rural tree decline. The reasons for ecological collapse of these forests include the impact of drought, grazing, exposure and possum browsing. Particular forest types are most susceptible and collapse can occur over just a few years or sometimes slowly. Once decline is evident the long term viability of the stand is increasingly doubtful. The forest patch must be determined to be in suitable health to warrant inclusion in the FCF. Consequently the FCF wishes to reduce the risk of including forests that are at risk of ecological collapse.

Eligibility is based on two criteria;

1. a minimum cover of 5% of healthy trees ie at least woodland cover of trees.
2. meeting a forest health test

The forest health is scored as:

1. ineligible for the FCF
2. eligible but significance reduced based on structural condition (see below)
3. eligible with no penalty

The method for determining forest health requires reference to photographs (see field manual). The photographs illustrate canopies of single trees and forest canopies. It is important that the **single trees** and **forest canopies** are considered separately.

A solid crown cover of 5% is the minimum cover to meet the RFA forest definition. If the tree cover is less than 5% the stand is not eligible for the FCF. This can be estimated, for example, trees with less than 10 m radius canopies that are greater than 100 m apart provide less than 5% cover.

A **healthy tree** cover of less than 5% may also occur in a forest of higher overall tree cover in which many of the trees are not healthy. If the **forest canopy** supports unhealthy trees (moderate or low canopy health as illustrated by photographs) then the healthy tree cover must be measured and the 5% cover test applied.

Once the healthy tree cover has been determined to meet the definition of forest the overall canopy heath is determined from the photographic reference. In addition to this, the cover class of exotic understorey vegetation is measured as a percentage of all understorey vegetation. Exotic vegetation includes pasture species minor herbaceous weeds and other low threat weeds.

The forest canopy health and the exotic vegetation classes are combined in a matrix (Table 2). The result expresses the forest health as 1 (poor), 2(moderate) or 3 (good).

If the forest health class is either 1 or 2 then it is important to determine if the forest has the potential to recover through regeneration. This can be estimated by determining if the healthy trees hold seed or if the forest supports lignotubers (root stock) that will grow if grazing is removed or has active regeneration. If the healthy trees are not holding seed or there are fewer than 10 lignotubers or active saplings per

ha then the forest health class is reduced by 1. If the final score for forest health is 1 the stand is not eligible for the FCF. If the final score is 2 then the structural condition (below) is reduced by 50 and grazing should be excluded to allow regeneration.

Table 2 Forest health. A matrix of the forest canopy health determined from photographic reference as (high (H) Medium (M) or low (L) and the cover class of exotic plants described above.

	% exotic understorey cover				
Forest canopy health	>75	50-75	25-50	5-25	<5
High	1	2	2	3	3
Moderate	1	1	2	2	3
Low	1	1	1	2	2

4. FOREST PRIORITY SCORE MODIFIERS

The modifiers described below have distance limited powers to reduce the Forest Priority Score. The maximum the FPS can be reduced by a condition modifier is 1/3 of the distance between its class and the bottom on the forest priority class below (***FPS*$_{D2}$**) ie 1/3 of two classes. The impacts of the modifiers are additive. One FPS class can be regained by the most under reserved forest types. The influence of each is described below.

4.1. Reservation status

$$\text{Influence on FPS} = + FPS_{D1} * (1 - RES / 100)$$

The aim of reservation is to reflect the current reserved area of a forest relative to a target reservation area. If current area is a long way from the forest type is preferred over types with a higher proportion reserved. The current reservation status is used to modify the forest priority score. Modification is based on the progress the forest type has made toward reaching the JANIS reservation target. The targets represent the proportion of a forest type that should be protected in the CAR reserve system. The progress is expressed as the percentage shortfall of the target. Preference is expressed for forest types that are least reserved in relation to the JANIS target. Reservation status is used to differentiate within a forest priority class, not between classes. The least reserved forest type within a classification can regain the FPS points within that classification that have been lost due to condition modifiers. For instance, class 1 = 6, class 7 = 15.

The JANIS targets for reservation are:

- Rare or depleted old growth 100%
- Rare or endangered forest types 100%
- Vulnerable forest types 60%

- All other old growth 60%
- All other forest types 15%

4.2. Modifier 1. Structural Condition (StC)

$$\text{Influence on FPS} = -\tfrac{1}{3} FPS_{D2} * (1 - StC / 50)$$

The structural condition of a forest is a description of the forest growth stage based on the structure of the forest canopy. The structural condition is derived from the RFA Forest Resource Type assessment **(reference)**. In that assessment all old growth forest is mature forest but not all mature forest is old growth forest. The assessment of the structural condition of the forest assists in verifying the presence of old growth forest. The structural condition (forest resource type) is already mapped at the landscape scale it assists in field assessments where boundaries of old growth and all other growth stages need to be indicated. These boundaries are often coincident with FPS classes as well.

It is reasonable to adjust the significance of forest due to its structure because undisturbed mature forest is of greater importance to the FCF than disturbed regrowth forest. Mature forests offer habitat elements that are not found in regrowth forests and are increasingly rare, for example nesting hollows and logs. Also, the abundance of regrowth forest is high compared to mature forest and is increasing due to the impact of logging. Consequently, the structure of the forest is a measure indicating the relative abundance within each forest type. Because of this preference for the rarer forest structure it is useful to score mature forest higher than regrowth to promote the CAR principles.

Structural condition scores range from 0-50 and apply differently to old growth forest and non-old growth forest. This is because old growth only occurs in one structural class ie mature, and so the score reflects that. If non old growth forest structure has been altered as a result of logging or wood getting (firewood, fence posts) in the past 40 years then the structural condition score is reduced from 50 by the amounts indicated in (Table 3). Logging before industrial scale clear felling is assumed to be negligible disturbance now.

Table 3. Reduction in CCV due to structural condition.

Old growth forest	
Density of stumps/downers	***Reduction in score***
Structure unaltered by logging or wood getting	50
Large stumps present, >= 1/ha, or	5
Large stumps present, < 1/ha	2
Small stumps present, >= 5/ha, or	3
Small stumps present, <5/ha	1
Cut downers present	2
Not old growth forest	
Current structure	***Reduction in score***
Structure not significantly altered by logging or wood getting defined by cut stumps present <4 large and <10 small /ha	50
Mature forest	40
Predominantly mature, some regrowth	30
Predominantly regrowth, some mature	20
Regrowth forest	10
Silvicultural regeneration (post-clear felling)	0

In old growth forest the reductions in scores for logging/wood cutting disturbance in old growth forest are cumulative.

For example, an old growth forest having:

large stumps >1/ha **and** small stumps >5/ha **and** cut downers present would have its benchmark condition score reduced by 5 + 3 + 2 = 10

By comparison, a non-old growth forest whose structure has been significantly altered by wood getting and which is mature would also have its condition score reduced by 10. The structural classes for non old growth forests are mutually exclusive.

The maximum loss of structural components for old growth forest has been set at 10 as further site disturbance beyond this level would likely disqualify the forest from being old growth. In this circumstance the forest would be assigned (in the field) to the appropriate forest priority for its type and its structural condition scored as non old growth. If the forest health (from previous assessment) is moderate the structural condition is recorded as zero regardless of logging or cutting disturbance.

4.3. Modifier 2. Current Condition Value (CCV)

The current condition of the forest is calculated starting with a Benchmark Condition Value (BCV). It represents a normalised view of the undisturbed natural condition of forest types set at 100. The BCV is modified by the observed condition.

CCV= BCV- Observed Condition

The observed condition estimates the intensity of the impact that *Phytophthora cinnamomi,* weeds and grazing have had on a forest's condition. The impact of *Phytophthora cinnamomi*, weeds or stock grazing can be reduced by actively providing management services that will improve the forests condition by reducing or controlling the impact.

The impacts assessed here were selected as the three main property scale impacts on condition that can be managed. For example, the impact of domestic grazing can be removed by the construction of a fence to exclude stock or reduced by adjusting stocking rates, or the abundance of a weed can be reduced by application of herbicide or by physical removal. The level of impact of each is classed in the range 1-4 (1 absent, 4 the highest or most intense impact).

While a number of other activities that impact on condition exist, for example fire wood collecting and native animal grazing, they can either be controlled by standard prescriptions in the restrictive covenant or management plan and or else are not easily managed or measured, for example, feral animal control, the impact of horse riding or recreational use. Duty of Care or other legislative provisions, e.g. protection of threatened species, management of feral animals such as deer in accordance with Tasmanian requirements are existing tools that can be brought to bear on management. Exogenic factors that may impact on condition but for which there are no direct management actions, for example salinity, are not considered either.

The costs and benefits of managing these impacts are considered in Service (below).

4.3.1 Measurement of the elements of Current Condition Value

Phytophthora cinnamomi

Phytophthora cinnamomi is a root-rot fungus which affects vegetation types within which it kills susceptible species. The impact of infection may be the loss of some or all susceptible plants and or species and simplification of forest structure. Once established it is almost impossible to eradicate from an area and consequently its potential to impact is effectively irreversible. A number of fauna species may be affected by the loss of plant species that are important in their own ecology. While some old growth characteristics remain unaffected by the occurrence of the disease, for example the presence of logs and hollows an extensive and severe impact may be sufficient to alter the faunal and floral community composition and so reduce the value of the forest to the FCF.

The only practical method of control is by hygiene protocols and quarantine measures in susceptible vegetation types, especially control of vehicular access. Hence, the potential impact of *Phytophthora cinnamomi* can be managed by the provision of a service ie closure of roads.

Current condition for *Phytophthora cinnamomi* (PC) is derived from susceptibility of the forest, the presence/absence of PC at the site and the presence/absence of roads at the site (Table 4). The presence or absence will be based on symptomatic evidence of

disease. Laboratory isolation from roots or soils is the only definitive confirmation of the presence of PC. However, symptomatic evidence allows a conservative assumption of its presence to be made and this potentially reduces the risk of the spread of PC and hence a reduction in the value of the forest.

Forest *Phytophthora cinnamomi* susceptibility is determined from the lookup table of susceptibility of each forest community and the location in relation to the bioclimatic envelope of site suitability for PC (Appendix 3)

Phytophthora cinnamomi condition is scored in the field assessment using the rules shown in Table 3. The presence or absence of roads affects assessments differentially; being scored equal where PC and roads are absent but reflecting the susceptibility of the forest where roads are present (see row PC absent). Where PC and roads are both present there is a step from 2 points for low susceptibility forests to 4 points for moderate and high susceptibility. This step reflects the disproportionate rise in potential impact of the combination. The schema does not take account of the potential for walkers or animals to disperse PC into "clean" sites or within sites that are already infected. This means that the only easily achievable action[5] is the closure or prohibition of roads. Table 3 below indicates the observed condition scores for each class of forest susceptibility based on the presence or absence of *Phytophthora cinnamomi* and roads. Otherwise susceptible forest types that occur outside of the range of significant impact of *Phytophthora cinnamomi* will score 1.

Table 4. Forest susceptibility, the presence or absence or roads and the presence or absence of *Phytophthora cinnamomi* in a forest patch.

	Forest Susceptibility class					
	Roads absent			Roads present		
	Low	Moderate	High	Low	Moderate	High
PC Absent	1	1	1	2	3	3
PC Present	2	3	4	2	4	4

[5] The application of phosphonate to vegetation can control the spread and impact of disease. The application of phosphonate needs to be repeated at regular intervals and can have deleterious effects on soil biology.

Weeds

Observed condition for weeds was derived from an assessment of the types of weed potentially present and posing a moderate or major ecological threat (Appendix 4). Minor weeds were identified but excluded from further assessment as they have minimal ecological impact. The weeds were selected from Weeds of National Significance (WONS) (EPBC Act 1999) and Declared Weeds (Tasmanian Weed Management Act 2002), selected environmental weeds were also considered. WONS were not automatically considered to be major weeds but rather were classed based on the potential impact in forests. Aquatic weeds were not deemed to threatened forests.

Increasing weed abundance increases the potential ecological impact. The assessment of abundance is based on the % cover and distribution of weeds species using modified Braun-Blanquet cover and sociability classes (Table 5). Weeds that can produce a moderate ecological impact are assumed to be able to produce an equal ecological impact to that of major weeds at lower abundance (Table 6). This assumption recognises the interaction between weed type and abundance in the intensity of an impact. Where two classes of weeds co occur the worst case is scored. Where categories of weeds are spatially separated then each occurrence is scored separately.

The sociability classes are

- Continuous – widespread, extensive and possibly too numerous to count, occurring regularly throughout the area
- Clumped – concentrated, discrete patch or patches.
- Scattered – single plants or small clumps (2mx2m) irregularly distributed

Table 5. Weed Abundance classes (range 1-4 for each of the Braun-Blanquet % cover classes and distribution patterns.

Cover abundance	Absent	Clumped	Scattered	Continuous
Absent	0	na	na	na
<1% cover	na	1	1	2
1-5% cover	na	1	2	3
5-25% cover	na	3	4	4
> 25% cover	na	4	4	4

Table 6 indicates the scores for Relative Ecological Impact of Weed Abundance classes according to the type of weed present. For example, a major weed (e.g. Gorse *Ulex europaeus*) has a greater ecological impact (score 4) compared to the same cover of a moderate weed such as Slender Thistle (*Carduus pycnocephalus* – score 3) in the same Weed Abundance class.

Table 6 The ecological impact of weed infestation scored in a matrix of Weed type (moderate or major) and Weed Abundance class (0-4)

Weed Abundance	Weed type Moderate	Major
0	1	1
1	2	2
2	2	3
3	3	4
4	4	4

Stock Grazing

Observable condition for grazing was derived from an assessment of the forest sensitivity of forest communities to grazing and the stocking rate for commercial grazing. The period of assessment for stocking rate is the past 10 years. While total grazing pressure includes grazing by feral and native animals the assessment is confined to management of commercial grazing. With the removal of domestic grazing animals the grazing pressure from native and feral fauna is likely to be at least adequate to fulfil the ecological needs of the forests.

Appendix 3 lists the utilisation and sensitivity of each forest type to grazing.

The stocking rate was classed according to the sensitivity of the forest community as follows: (note that the following rates are not recommended rates they are a measure of impact).

- For low sensitivity forests,
    1. No domestic stock grazing
    2. Low = >0-1.0 dse,
    3. Moderate = 1.0-1.5 dse,
    4. High >1.5 dse; and
- For moderate and high sensitivity forests,
    1. No domestic stock grazing
    2. Low = >0-0.5 dse,
    3. Moderate = 0.5-1.0 dse,
    4. High >1.

dse = dry sheep equivalent per hectare

Feral and native animal grazing

The effectiveness of controlling the grazing pressure of feral and native animals is at least in part dependent upon the efforts of others at sites remote from the proposal.

The control of wallaby, for example is difficult in a small reserve surrounded by forest owned by someone else who is not controlling deer. As such the level of control or "improvement" cannot be identified or measured in the same way as domestic grazing over which the owner has absolute control. The incentive to manage excessive grazing pressure generally arises from the need to protect pastures and crops. Excessive grazing pressure by feral and native animals should be dealt with in a property based game management plan. All properties with FCF reserves should be encouraged to have game management plans in which the legitimate control of wallaby, possum, rabbits and deer are all addressed.

Native animal abundance, particularly in small remnants, is generally higher today than natural levels due to the increased carrying capacity of improved pasture and feral animals add to this pressure. Given this circumstance we assume that native and feral grazing pressure is likely to be sufficient to maintain ecological processes that are dependant upon grazing. That is, no domestic stock grazing is required to fill a management role. However, in a healthy and extensive native forest the moderate level of intensity may be ecologically sustainable (sustains floristics and structure of community but will affect relative abundance); the higher level of commercial grazing may alter the floristics and structure of the community.

4.3.2 Calculation of Observed Condition

$$\text{Influence on FPS} = -\frac{1}{3} FPS_{D2} * OC / 100$$

Each combination of scores for *Phytophthora cinnamomi*, weeds and grazing was generated (n=64) and the combinations ranked in descending order based on the perceived ecological impact of all three threats in combination (Table 7). Thus ranks range from 64 to 1. This range is standardised between 0 and 100 and used to determine the observable condition (percent loss of current condition) for each rank. Zero being the best condition (no observed loss of condition) and 100 the poorest (complete loss).

Ranking rules:

- Combinations of the observed impact of *Phytophthora cinnamomi*, weeds and grazing were ranked initially on PC, then on weeds and then on grazing.
- Ranks were then adjusted on the basis that combinations could jump in rank where the weed condition was >=1 class worse than PC AND grazing condition >=2 classes worse than weeds.
- The extent of adjustment to the rank was based on the combined impacts on forest condition of each of the three condition measures.

Table 7 Observed Condition scores for *Phytophthora cinnamomi*, weeds and grazing.

PC (1-4)	Weeds (1-4)	Grazing (1-4)	RANK	Observed condition (-%)
4	4	4	64	100
4	4	3	63	98
4	4	2	62	97
4	4	1	61	95
4	3	4	60	94
3	4	4	59	92
4	3	3	58	91
3	4	3	57	89
4	3	2	56	88
4	3	1	55	86
3	4	2	54	84
3	4	1	53	83
4	2	4	52	81
4	2	3	51	80

PC (1-4)	Weeds (1-4)	Grazing (1-4)	RANK	Observed condition (-%)
3	3	4	50	78
3	3	3	49	77
4	2	2	48	75
4	2	1	47	73
3	3	2	46	72
3	3	1	45	70
4	1	4	44	69
4	1	3	43	67
4	1	2	42	66
4	1	1	41	64
2	4	4	40	63
2	4	3	39	61
3	2	4	38	59
3	2	3	37	58
2	4	2	36	56
2	4	1	35	55
3	2	2	34	53
3	2	1	33	52
2	3	4	32	50
2	3	3	31	48
3	1	4	30	47
3	1	3	29	45
1	4	4	28	44
1	4	3	27	42
1	4	2	26	41
1	4	1	25	39
2	3	2	24	38
2	3	1	23	36
3	1	2	22	34
3	1	1	21	33
2	2	4	20	31
1	3	4	19	30
1	3	3	18	28
2	2	3	17	27
1	3	2	16	25
1	3	1	15	23
2	1	4	14	22

PC (1-4)	Weeds (1-4)	Grazing (1-4)	RANK	Observed condition (-%)
2	2	2	13	20
1	2	4	12	19
2	2	1	11	17
2	1	3	10	16
1	2	3	9	14
2	1	2	8	13
1	1	4	7	11
1	2	2	6	9
2	1	1	5	8
1	2	1	4	6
1	1	3	3	5
1	1	2	2	3
1	1	1	1	0

4.4. Modifier 3. The Regional Threat Index (RTI)

$$\text{Influence on FPS} = -\frac{1}{3} FPS_{D2} * RTI / 100$$

A Regional Threat Index (RTI) has been calculated based on the risk of the potential impacts of *Phytophthora cinnamomi*, weeds and grazing being realised in the landscape context. The value of management actions in maintaining a forest in a condition better that the RTI predicts as a risk is attributed to the landowner as a maintenance score.

The RTI takes account of the variation in the susceptibility to *Phytophthora cinnamomi*, weeds and grazing of different forests in different environments. Each of these threats is scored according to the intensity of the threat and the susceptibility of forest. Weeds and grazing are scored in a two way matrix of high, moderate and low for intensity and susceptibility, *Phytophthora cinnamomi* is based only on the susceptibility of the forest within the suitable bioclimatic range of PC. The results are mapped on a statewide basis Appendix 3. Low threat equals 1 and high threat equals 3.

Phytophthora cinnamomi

The RTI for *Phytophthora cinnamomi* was constructed using a bioclimatic model of the range as the basis for the potential distribution of *Phytophthora cinnamomi.* Tertiary basalt was removed from the bioclimatic range as this fertile soil type is not conducive to disease.

Each forest type within the range of *Phytophthora cinnamomi* was attributed to a susceptibility class of high, moderate or low based on modifications to Rudman 2005[6] All forest outside of the range was attributed to low. Appendix 3.

Weeds

The RTI for weeds is based on the forest susceptibility to changes in forest structure and floristics due to invasion by weeds (Appendix 3). The threat is judged to be high if the community is susceptible to invasion without disturbance, moderate if susceptible after disturbance and low if not susceptible to invasion (Table 8). The distance from cleared land was applied to modify the threat of invasion (Table 9). The distance modifier essentially reflects edge effects and so, all else equal, larger patches of susceptible forests will be preferred over smaller ones.

Table 8 Weed susceptibility of forest

Weed susceptibility of forest
L= Limited susceptibility
M= Susceptible if disturbed
H= Susceptible in the absence of disturbance

Table 9 Threat Index for potential for weed invasion

		Community susceptibility		
		L	***M***	***H***
Distance from cleared land	**> 1 500 m**	**1**	**1**	**1**
	> 1 000 m	**1**	**1**	**2**
	> 500 m	**1**	**2**	**3**
	< 500 m	**2**	**3**	**3**

Grazing

The RTI for grazing is based on the probability of utilization and the sensitivity of the forest to grazing.

Utilisation is defined as:

- High if the forest type is part of the main resource for commercial grazing,
- Moderate if often grazed as part of a commercial enterprise

[6] Rudman 2005 Interim *Phytophthora cinnamomi* Management Guidelines Conservation Report 05/7 DPIWE Tasmania. (Where vegetation types are include in this report otherwise expert opinion P. Barker and M. Brown see Barker and Wardlaw 1993 and Barker and Brown 1994).

- Low if not generally grazed as part of a commercial grazing enterprise

Sensitivity is defined as:

- High if the forest is susceptible to long term floristic and structural change.
- Moderate if the forest is susceptible to change that is reparable in the medium term.
- Low if the forest is of limited susceptibility to change from grazing ie reparable in the short term.

Forest grazing risk is determined using a matrix of sensitivity and utilization (Table 10). A threat index was constructed by modifying the forest grazing risk by distance from agricultural land (Table 11). The distance modifier reflects the tendency for unfenced forest remnants to be grazed in conjunction with pastures and to be used for "off shears" etc. These activities essentially produce an edge effect and the measure will preference larger patches of forests over smaller ones.

Table 10 Forest community grazing risk

	Utilisation		
Sensitivity	***L***	***M***	***H***
Low	**L**	**L**	**M**
Moderate	**M**	**M**	**H**
High	**M**	**H**	**H**

Table 11 Threat index for grazing

		Community risk		
		L	***M***	***H***
Distance from agricultural land	**> 1 000 m**	**1**	**1**	**2**
	> 500 m	**1**	**2**	**3**
	< 500 m	**2**	**3**	**3**

4.4.1 Calculation of the RTI

Each combination of scores (1, 2 and 3) of the regional threats from *Phytophthora cinnamomi*, weeds and grazing was generated and the combinations ranked in descending order based on the potential combined ecological impact of all three factors (**Table 12**). There are 27 possible combinations ranked from 1-27 which are standardised from 0-100.

The following "rules" were applied to derive the RTI rankings:

- PC has high impact, is permanent & irreversible but does not totally remove ecosystem.
- Weeds potentially have a greater impact than grazing. Both may have a high impact but are not necessarily permanent and are reversible if remediated in time.
- First ranked threat is that which is potentially irreversible, i.e. PC.
- Second ranked threat is weed infestation, which is potentially manageable but more difficult than the threat from grazing.
- Third ranked threat is grazing which is potentially manageable in many cases.
- All land of high PC risk ranks moderate to high on the RTI, according to associated threats from weeds and grazing.
- Moderate PC & combined high weed & grazing threat also ranks relatively highly on the RTI.

Final RTI values were ranked by considering the relative impacts of all combinations of threat. The RTI is linearly ranked from greatest threat down to least threat.

Table 12. All combinations of threat from *Phytophthora cinnamomi*, weeds and grazing, ranked in order of combined ecological impact and standardized between 0 (lowest regional threat) and 100 (highest regional threat)

PC	Weed	Grazing	Rank	RTI (0 - 100)
3	3	3	27	100
3	3	2	26	96
3	2	3	24	88
3	3	1	25	92
3	1	3	23	85
2	3	3	22	81
3	2	2	21	77
3	2	1	20	73
3	1	2	19	69
2	3	2	18	65
2	2	3	17	62
3	1	1	16	58
1	3	3	15	54
2	3	1	14	50
2	1	3	12	42
2	2	2	13	46
1	3	2	11	38
1	2	3	10	35
2	2	1	9	31
2	1	2	7	23
2	1	1	6	19
1	3	1	8	27
1	1	3	5	15
1	2	2	4	12
1	2	1	3	8
1	1	2	2	4
1	1	1	1	0

5. FOREST SERVICES

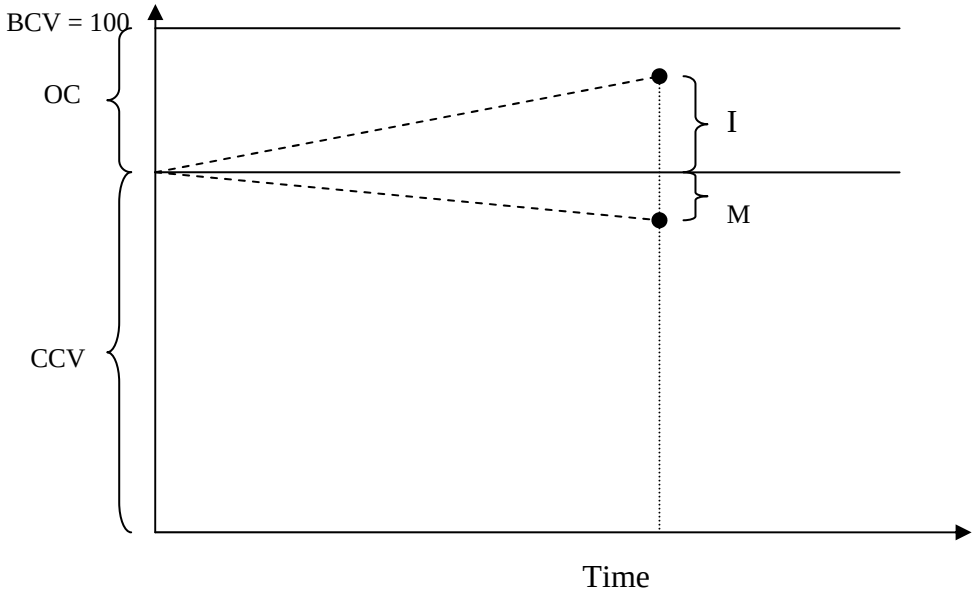
Service = maintenance + Improvement

Influence on CVI = multiplicative

The opportunity to include services in proposals allows landowners to provide greater ecological benefits than are offered by the protection of forest in its unmanaged state. On private land much of the conservation effort is associated with the need for **maintenance** of forest sites or **improvement** of forest sites where the need exists. The management service is particularly important to long term reserve viability because the change in land use from commercial to forest reserve often results in the rapid spread of weeds into the reserve.

The multiplicative influence of maintenance and improvement on FPS provides a greater range of scores in the CVI and so makes discrimination easier. The relative scale influences of I and M are uniform across all FPS classes. This could potentially lead to some situations where forests with lower FPS and with high service scores overtake the opposite. However, this is unlikely to happen on a broad area basis. This is because the need for improvement through active management tends to reflect the principals included in the RTI. That is, that the risk of high intensity of impacts is **generally** limited to a certain distance from the forest edge. This balance is a pragmatic trade-off and the extra scale it provides makes communication of purchase decisions easier.

Figure 4 below is a schematic depiction of the relationships between the bench mark condition value, observable condition and the current condition value as well as the value of improvement and maintenance over time.



Note: if BCV = 100 then I = 0. That is, improvement cannot exceed the maximum BCV.

Figure 4. Service as a function of maintenance and improvement

The financial costs of undertaking management of the impacts will be borne by the proponent and the proposal will be rewarded in the CVI as a measure of improvement. The cost to the FCF of allowing the proponent to nominate management options is the potential for proponents to opt out of any management and hence a reduction in the EGS provided by the forests. The benefits to the FCF of undertaking the management actions are the embellishment of the EGS provided by the forest which is a major consideration in the strategic plan.

In selecting manageable threats only a limited range of threats have been considered and described above in the assessment of observed condition. Some threats are a duty of care for land managers (eg erosion control), some are manageable threats that are not a duty of care (removal of weeds) and others are unmanageable threats (climate change). The three elements included here, *Phytophthora cinnamomi*, weeds and grazing, are generally perceived as the main manageable threats affecting the ecological viability of the forest. Each is directly manageable and the level of service is expressed through a landowner choice from a selection of intended management outcomes ie future condition.

The effects of past logging and firewood collection on structural condition are only reparable by prohibition and the period of time that the land is protected by covenant. The future management of ongoing firewood collection and other "secondary" threats will be dealt with in a standard way that does not attract a value in the CVI.

5.1. Maintenance (M)

Maintenance = CCV * 0.3

The FCFSP recognises the importance of protecting the future of forested sites. The better the condition of the forest now the more there is to lose in future, therefore an ad valorem amount was considered appropriate. The value of maintenance is a function of the current condition. A value of thirty percent of the current condition value (CCV) was seen as reasonable when considered within the context of the score attainable in the improvement element (see below).

The maximum maintenance score is 30 points for a forest that has the maximum current condition value of 100. Where a lower quality forest say CCV= 50 can only score 15 points.

The level of management required to achieve the above varies between forest types in different parts of the landscape and in response to different land uses. As such the cost of maintenance is determined by the landholder but is informed by their context within the landscape. They discuss this with the field officer who advices the landholder about the minimum they need to undertake to ensure condition does not deteriorate and maintenance is achieved.

It is often the case that a forest is in its current "good" condition due to past management actions. There is little opportunity for landholders to improve the site but they get a high service score because the site has been maintained well to date, they are recognised for past *good* behaviour and the FCF benefits from the inclusion of and maintenance of forest in good condition.

5.2. Improvement (I)

Improvement = Delta (CCV Rank)

Landowners are invited to nominate element/s of *Phytophthora cinnamomi*, weeds and stock grazing they intend to manage and the extent they intend to manage it. The magnitude of the change (ie improvement) ranges from 0 to 36 (0 represents no improvement and 36 represents the maximum possible). The score is based on the change in rank of CCV (aggregated impact of PC, weeds and stock grazing) to the intended class. That is the change between the CCV now and the proposed CCV due to active management by landholder. This is the measure of change (Delta CCV).

The improvement in the condition of the forest is contingent upon improving the forests current condition by, for example, removing or reducing the impacts of weeds, closing a track to reduce the risk of spread of *Phytophthora cinnamomi* or reducing the stocking rate of sheep.

A maximum improvement for each element of the CCV that can be gained potential improvement has been set at 1 class for *Phytophthora cinnamomi,* 2 classes for weeds and 3 classes for grazing. This equals a maximum change in rank of 36. The rank change can be determined from table 6 by subtracting the proposed rank from the current rank.

The proposed change in score for each element of management is determined in discussions with the advisor. If a landholder has a very high weed infestation (score 4) they have the choice of doing nothing or improving it to score 3 or 2. However, the effort required to do nothing, move to 3 or move to 2 increases and the landholder would need to take this into account in their proposal.

The method by which the landholder achieves the change is up to them but information will be provided (where available) indicating recommended practices. The contract needs to specify reporting arrangements for the inputs used, the minimum standards to apply (where applicable) and potentially the season within a year the works are expected to be completed.

5.3. Security

Security can be included as a weighting to the CVI (multiplicative) or a separate score that is added to the CVI. The weighting approach attaches a security scaling to the CVI while the separate score approach suggests that security is a separate attribute unrelated to the CVI. Because security relates to the protection of CVI through the period of the contract a weighting approach is preferred. The weighting approach addresses the improvement in structural condition provided by time.

The suggested benefits index would then be:

Security weighted CVI = CVI * security

The scale of the security weighting is the next question. There are three possible models to apply to calculate the weightings. First, a financial model based on the comparative costs of protection from hypothetical repeat contracts; second, a present value model of predicted protection value; and third, a political model.

The weightings estimated financial model employs the following assumptions:

1. The probability of change of land use is the same for all bids offered (this is implicit in the CVI calculation method in any case);
2. Repeat contracts with identical CVI provision can be purchased at the same real cost as initial contracts;
3. The costs of repeat contracting are negligible compared to overall costs.

The financial model assumes that, for each non-perpetuity contract, a sufficient amount of money is hypothetically invested to allow repeat contracts. The ratio between the total costs for achieving protection over a 50 year period (beyond which any discounted costs in either model would be very small) under each option is the weighting. That is, the model compares the cost of permanent protection (via covenant) against repeat contracts to achieve the same end (although the "repeat" aspect is hypothetical).

For the following contract periods with differing discount rates for different periods of contract the following weightings would apply:

Discount rate	3%	5%	7%
Perpetuity	4.9	3.7	2.9
Twelve years	2.8	2.1	1.8
Six years	1.0	1.0	1.0

For example, using a 5 percent discount rate, a six year contract would receive a weighting of 1, twelve years, 2.1 and perpetual, 3.7. .

An alternative option is to assume that each forest generates the estimated CVI on an annual basis. Discounting a future stream of benefits to a present value would then allow a weighting of differential options based on length of contract and relative benefits from each proposal. Hence, a six year contract is assumed to generate the estimated CVI for 6 years, a 12 year contract for 12 years and so on. The obvious problem is that the CVI is intended to estimate the value of a forest at some point in the future that is protected under the FCF. That is, the CVI is in-fact intended to be a discounted value rather than a stream of values. The issue of an appropriate discount rate is as per option 1.

The third option, though termed a political option, is intended to be a comparison of the willingness to pay for different length contracts. In theory this should collapse to the financial model expressed as the first option. In practice there are many observed values to suggest that societal discount rates for environmental investments differ substantially from financial discount rates (particularly if there are irreversibilities involved). The sole guidance for this method (in the absence of community opinion in some form) is beliefs about the relevant values for different lengths of protection.

Suggested contract length options

There has been some discussion of which contract options should be available. Based on past experience we suggest that a menu of options with a short, medium and long-term contract option be presented. (For example 6, 12 and perpetual contracts). We see no value in a medium-long term contract in addition to either the 12 year or perpetual contracts due to the likely variation in government regulations over the

period of contract, and the lack of difference between the contract options (12 and perpetual).

Policy makers may choose to use additional weightings based on values attached to perpetuity that are not represented by a financial model. In this case we exercise no advice except that the direction of these considerations would most likely suggest higher weightings for perpetual contracts.

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APPENDIX I. ANALYSTICAL ASSESSMENT OF CVI

This section contains an analytical assessment of the relationships within the CVI of each element.

$$CVI = \left[FPS - \left(\tfrac{1}{3} FPS_{D2} * (1 - StC/50)\right) - \left(\tfrac{1}{3} FPS_{D2} * OC/100\right) - \left(\tfrac{1}{3} FPS_{D2} * RTI/100\right) + \left(FPS_{D1} * (1 - RES/100)\right)\right] * (M + I) * S$$

Where:

$CCV = BCV - OC$

$OC = BCV - CCV$

$M = 0.3 * CCV$

RES= min FPS_{D1}, FPS_{D2} loss (*1-RES/100*)

$I = \Delta RankCCV$

The table below summarises the variables used to the calculate the CVI – including maximum, minimum, expected value and distribution.

Variable	Min	Max	Expected Value	Distribution
FPS	8	100	??	Skewed towards the min.
StC – OG StC – NonOG	0 0	50 30		
CCV	0	50		
RTI	0	100		
$Fps–FPS_{FPS-1}$	-	-	8[a]	-
BCV	-	-	100	-

a) this is the average difference between FPS over all forest classes and is used in the calculations.

In this section we can plot rates of change etc and possibly report the Monte Carlo outcomes.

The following calculations require further consideration of:

- weights for improvements and maintenance
- how security will modify the final score (CVI).
- scale of adjustment of priority by current condition

APPENDIX II. FORESTS IN EACH FOREST PRIORITY CLASS AND SUMMARY INFORMATION

Table 1. Summary of JANIS criteria for reservation of forest communities and old growth forest. Under the objectives of the FCF the reservation target is applied within a bioregional framework.

Conservation status	General definition	Reservation target
Old growth forest		
Rare	Not defined, but assumed identical to forest community.	100% of extant area
Depleted	Less than 10% of extant area of forest community.	100% of extant area
Not threatened	Not defined, but all other old growth by default.	60% of extant area
Forest communities		
Endangered	Distribution less than 10% of former range; Total area less than 10% of pre-1750 extent; 90% of present area in small patches.	100% of extant area
Vulnerable	Approaching 70% reduction from pre-1750 extent; Not depleted but subject to continuing and significant threatening processes.	60% of extant area
Rare	Total range <10,000ha; Total area less than 1,000ha; Patch sizes generally <100ha with no significant aggregate area.	100% of extant area
Not threatened	Not defined, but all other forests by default.	15% of pre-1750 extent[7]

[7] A GIS coverage used to calculate the pre-1750 extent of forest communities was compiled during the RFA. For a description see Tasmanian Public Land Use Commission (1996b).

APPENDIX III. FOREST SUSCEPTIBILITY TO THREATS

The susceptibility of forests to impacts by *Phytophthora cinnamomi* and weeds and the utilisation of and sensitivity to grazing.

Tasveg code	Description	PC_suscepz	Weed_suscz	Graz_utilz	Graz_sensz	Graz_riskz
DAC	Eucalyptus amygdalina coastal forest and woodland	3	3	2	2	2
DAD	Eucalyptus amygdalina forest and woodland on dolerite	2	3	2	1	1
DAM	Eucalyptus amygdalina forest and woodland on mudstone	2	3	2	2	2
DAS	Eucalyptus amygdalina forest and woodland on sandstone	2	3	2	2	2
DAZ	Eucalyptus amygdalina inland forest and woodland on Cainozoic deposits	2	3	3	2	3
DBA	Eucalyptus barberi forest and woodland	2	na	2	2	2
DCO	Eucalyptus coccifera forest and woodland	1	1	3	2	3
DCR	Eucalyptus cordata forest	2	na	2	2	2
DDE	Eucalyptus delegatensis dry forest and woodland	1	3	2	2	2
DDP	Eucalyptus dalrympleana - Eucalyptus pauciflora forest and woodland	1	na	2	2	2
DGL	Eucalyptus globulus dry forest and woodland	1	3	3	1	2
DGW	Eucalyptus gunnii woodland	1	1	3	2	3
DKW	King Island Eucalypt woodland	2	na	3	2	3
DMO	Eucalyptus morrisbyi forest and woodland	2	3	3	2	3
DMW	Midlands woodland complex	1	na	3	2	3
DNF	Eucalyptus nitida Furneaux forest	3	2	1	2	2

Tasveg code	Description	PC_suscepz	Weed_suscz	Graz_utilz	Graz_sensz	Graz_riskz
DNI	Eucalyptus nitida dry forest and woodland	3	2	2	2	2
DOB	Eucalyptus obliqua dry forest and woodland	2	3	2	2	2
DOV	Eucalyptus ovata forest and woodland	1	3	2	2	2
DOW	Eucalyptus ovata heathy woodland	2	na	2	2	2
DPD	Eucalyptus pauciflora forest and woodland on dolerite	1	3	3	1	2
DPE	Eucalyptus perriniana forest and woodland	2	na	1	2	2
DPO	Eucalyptus pauciflora forest and woodland not on dolerite substrates	1	3	2	2	2
DPU	Eucalyptus pulchella forest and woodland	2	3	3	1	2
DRI	Eucalyptus risdonii forest and woodland	2	2	1	2	2
DRO	Eucalyptus rodwayi forest and woodland	2	2	3	1	2
DSC	Eucalyptus amygdalina - Eucalyptus obliqua damp sclerophyll forest	2	3	2	2	2
DSG	Eucalyptus sieberi forest and woodland on granite	2	2	2	2	2
DSO	Eucalyptus sieberi forest and woodland not on granite substrates	2	2	2	2	2
DTD	Eucalyptus tenuiramis forest and woodland on dolerite	2	2	3	2	3
DTG	Eucalyptus tenuiramis forest and woodland on granite	2	1	2	2	2
DTO	Eucalyptus tenuiramis forest and woodland on sediments	2	3	2	2	2
DVC	Eucalyptus viminalis - Eucalyptus globulus coastal forest and woodland	2	3	2	2	2
DVF	Eucalyptus viminalis Furneaux forest and woodland	1	2	2	2	2
DVG	Eucalyptus viminalis grassy forest and woodland	1	3	3	1	2
DVS	Eucalyptus viminalis shrubby/heathy woodland	2	na	2	2	2

Tasveg code	Description	PC_suscepz	Weed_suscz	Graz_utilz	Graz_sensz	Graz_riskz
NAD	Acacia dealbata forest	1	3	1	3	2
NAF	Acacia melanoxylon swamp forest	1	2	1	3	2
NAL	Allocasuarina littoralis forest	2	na	2	2	2
NAR	Acacia melanoxylon on rises	1	3	1	2	2
NAV	Allocasuarina verticillata forest	1	2	2	2	2
NBA	Bursaria - Acacia woodland and scrub	1	na	3	1	2
NBS	Banksia serrata woodland	3	1	2	2	2
NCR	Callitris rhomboidea forest	2	2	2	2	2
NLA	Leptospermum scoparium - Acacia mucronata forest	2	na	1	3	2
NLE	Leptospermum forest	1	na	1	3	2
NLM	Leptospermum lanigerum - Melaleuca squarrosa swamp forest	1	1	1	3	2
NLN	Subalpine Leptospermum nitidum woodland	1	na	1	3	2
NME	Melaleuca ericifolia swamp forest	1	2	1	3	2
NNP	Notelaea - Pomaderris - Beyeria forest	1	1	1	3	2
RFE	Rainforest fernland	1	na	1	3	2
RFS	Nothofagus gunnii rainforest and scrub	1	na	1	3	2
RHP	Lagarostrobos franklinii rainforest and scrub	1	1	1	3	2
RKF	Athrotaxis selaginoides - Nothofagus gunnii short rainforest	1	1	1	3	2
RKP	Athrotaxis selaginoides rainforest	1	1	1	3	2
RKS	Athrotaxis selaginoides subalpine scrub	1	na	1	3	2
RKX	Highland rainforest scrub with dead Athrotaxis selaginoides	1	na	1	3	2
RLS	Leptospermum with rainforest scrub	1	na	1	3	2
RML	Nothofagus - Leptospermum short rainforest	1	na	1	3	2
RMS	Nothofagus / Phyllocladus short rainforest	1	1	1	3	2

Tasveg code	Description	PC_suscepz	Weed_suscz	Graz_utilz	Graz_sensz	Graz_riskz
RMT	Nothofagus - Atherosperma rainforest	1	2	1	3	2
RPF	Athrotaxis cupressoides/Nothofagus gunnii short rainforest	1	1	1	3	2
RPP	Athrotaxis cupressoides rainforest	1	1	1	3	2
RPW	Athrotaxis cupressoides open woodland	1	na	1	3	2
WBR	Eucalyptus brookeriana wet forest	1	1	1	3	2
WDA	Eucalyptus dalrympleana forest	1	na	1	3	2
WDB	Eucalyptus delegatensis forest with broadleaf shrubs	1	na	1	3	2
WDL	Eucalyptus delegatensis forest over Leptospermum	1	na	1	3	2
WDR	Eucalyptus delegatensis over rainforest	1	na	1	3	2
WDU	Eucalyptus delegatensis wet forest (undifferentiated)	1	1	1	3	2
WGK	Eucalyptus globulus King Island forest	1	2	2	3	3
WGL	Eucalyptus globulus wet forest	1	na	1	3	2
WNL	Eucalyptus nitida forest over Leptospermum	1	na	1	3	2
WNR	Eucalyptus nitida over rainforest	1	na	1	3	2
WNU	Eucalyptus nitida wet forest (undifferentiated)	1	1	1	3	2
WOB	Eucalyptus obliqua forest with broadleaf shrubs	1	na	1	3	2
WOL	Eucalyptus obliqua forest over Leptospermum	1	na	1	3	2
WOR	Eucalyptus obliqua forest over rainforest	1	na	1	3	2
WOU	Eucalyptus obliqua wet forest (undifferentiated)	1	1	1	3	2
WRE	Eucalyptus regnans forest	1	1	1	3	2
WSU	Eucalyptus subcrenulata forest and woodland	1	1	1	3	2
WVI	Eucalyptus viminalis wet forest	1	2	1	3	2

APPENDIX IV. WEEDS CONSIDERED FOR POTENTIAL IMPACT

Table 1. Partial list of Declared Weeds in Tasmania (July 2006) and other weeds known to cause a high impact on native vegetation. The list also includes weeds known to have a high impact on native vegetation that are not declared. These weeds are denoted by a '*'. Rank (1 Moderate and 2 Major Weeds).

Number	Scientific name	Common name	Rank
1.	*Acer pseudoplatanus*	Sycamore Maple	1*
2.	*Achnatherum caudatum*	Espartillo	2#
3.	*Amaranthus albus*	Tumble Weed, White Pigweed	2#
4.	*Ammophila arenaria*	Marram Grass	1*
5.	*Asparagus asparagoides* (= *Myrsiphyllum asparagoides*)	Bridal Creeper	2#
6.	*Asparagus scandens*	Asparagus Fern, Climbing Asparagus	2#
7.	*Berberis darwinii*	Darwin's Barberry, Berberis	2#
8.	*Calluna vulgaris*	Heather, Ling, Scots Heather	2#
9.	*Chamaecytisus palmensis*	Tree Lucerne	2*
10.	*Carduus nutans*	Nodding Thistle	2#
11.	*Carduus pycnocephalus*	Slender Thistle	1
12.	*Carduus tenuiflorus*	Slender Thistle	1
13.	*Carex flagellifera*	Sedge	2#
14.	*Carthamus lanatus L.*	Saffron Thistle	1#
15.	*Chrysanthemoides monilifera* (including subspecies)	Boneseed, Bitou Bush	2#
16.	*Cirsium arvense*	Californian Thistle	1
17.	*Coprosma repens*	Mirror Bush	2*
18.	*Coprosma robusta*	Coprosma, Karamu	2#

Number	Scientific name	Common name	Rank
19.	*Cotoneaster spp.*	Cotoneaster	1*
20.	*Cortaderia* spp.	Pampas Grasses	2#
21.	*Crocosmia x crocosmiiflora*	Montbretia	2*
22.	*Crataegus monogyna*	Hawthorn	2*
23.	*Cynara cardunculus*	Artichoke Thistle	2#
24.	*Cytisus scoparius*	English Broom	2
25.	*Datura* spp.	Datura	1#
26.	*Delairea odorata*	Cape Ivy	2*
27.	*Echium plantagineum*	Paterson's Curse	2#
28.	*Echium vulgare*	Viper's Bugloss	1#
29.	*Emex australis*	Spiny Emex	1#
30.	*Equisetum* spp.	Horsetail	2#
31.	*Eragrostis curvula*	African Lovegrass	1#
32.	*Erica lusitanica*	Spanish Heath	2
33.	*Euphorbia paralias*	Sea Spurge	1*
34.	*Fallopia japonica*	Japanese Knotweed	2#
35.	*Foeniculum vulgare*	Fennel	1
36.	*Genista monspessulana*	Montpellier Broom	2
37.	*Hieracium* spp.	Hawkweed, Orange Hawkweed, Mouse Ear Hawkweed	2#
38.	*Hypericum perforatum*	St John's Wort	2#
39.	*Hypericum tetrapterum*	Square-stemmed St John's Wort	2#
40.	*Ilex aquifolium*	Holly	2*
41.	*Leycesteria formosa*	Himalayan Honeysuckle	2#
42.	*Lycium ferocissimum*	African Boxthorn	2

Number	Scientific name	Common name	Rank
43.	*Marrubium vulgare*	Horehound	1
44.	*Myriophyllum aquaticum* (= *M. brasiliense*)	Parrot's Feather	2#
45.	*Nassella neesiana*	Chilean Needle Grass	2#
46.	*Nassella trichotoma*	Serrated Tussock	2#
47.	*Onopordum* spp.	Onopordum Thistles	1#
48.	*Orobanche* spp. (except *O. minor* and *O. cernua var. australiana*)	Broomrape	1#
49.	*Paraserianthes lophantha*	Cape Leeuwin Wattle	2*
50.	*Pennisetum macrourum*	African Feathergrass	2#
51.	*Pennisetum villosum*	Feathertop	1#
52.	*Pinus radiata*	Radiata Pine	2*
53.	*Pittosporum undulatum*	Sweet Pittosporum	1*
54.	*Psoralea pinnata*	Blue Butterfly Bush	2*
55.	*Rorippa sylvestris*	Creeping Yellowcress	1#
56.	*Rosa rubiginosa*	Briar Rose	2*
57.	*Rubus fruticosus* agg.	Blackberry	2
58.	*Salix* spp. except *S. babylonica, S. X calodendron* and *S. X reichardtii*	Willows except weeping willows, pussy willow and sterile pussy willow	2
59.	*Salphichroa origanifolia*	Pampas Lily-of-the-Valley	1#
60.	*Senecio jacobaea*	Ragwort	2
61.	*Sollya heterophylla*	Bluebell Creeper	2*
62.	*Solanum marginatum*	White-edged Nightshade	1#
63.	*Solanum triflorum*	Cut-leaf Nightshade	1#
64.	*Ulex europaeus*	Gorse	2

Number	Scientific name	Common name	Rank
65.	*Urospermum dalechampii*	Mediterranean Daisy	1#
66.	*Vinca major*	Blue Periwinkle	1*
67.	*Xanthium* spp.	Burrs	1#
68.	*Zizania species*	Wild Rice	1#

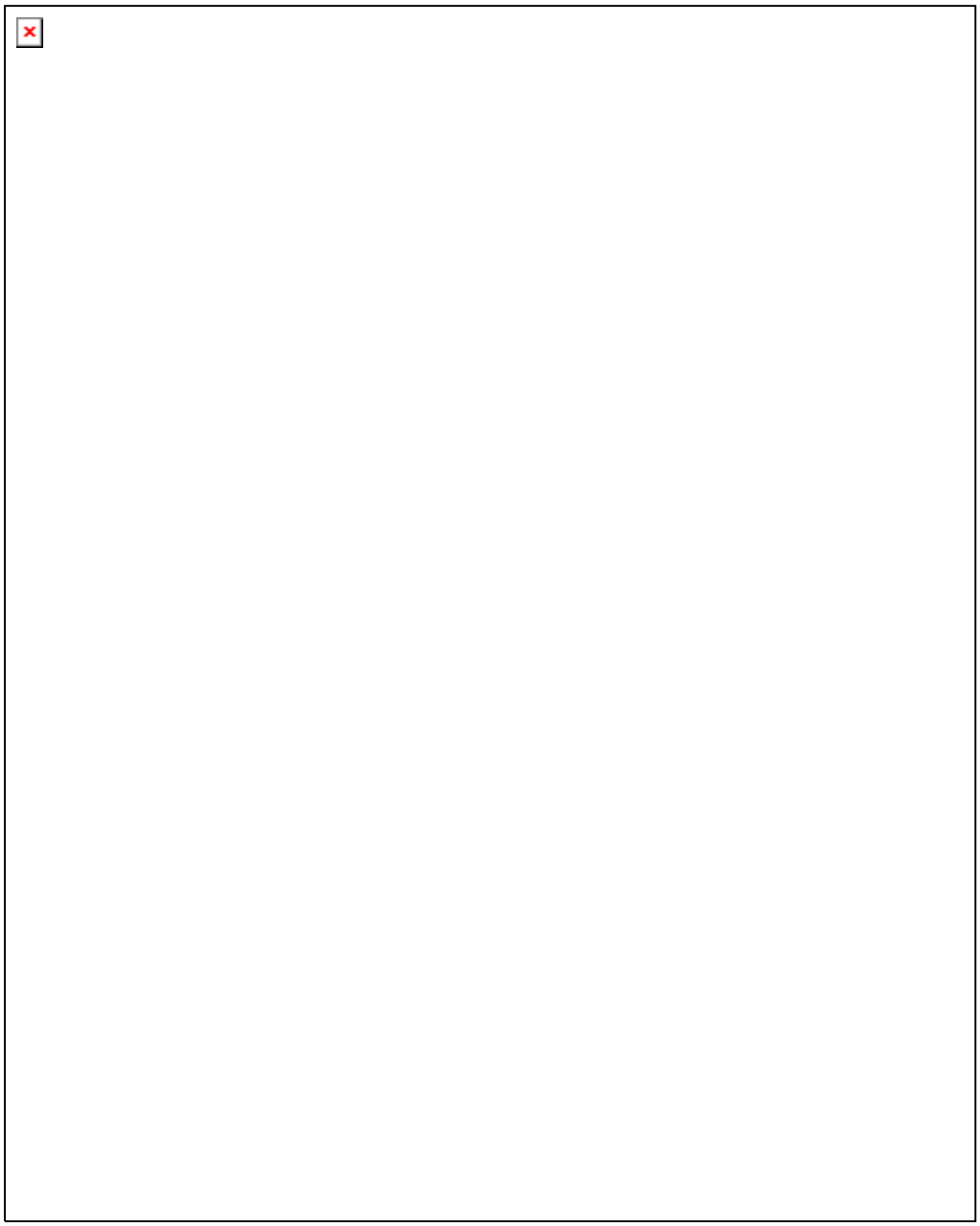
Table 2. Weeds that are declared in the *Tasmania Weed Management Act 1999* but which are not known to occur in Tasmania. If any of these weeds are recorded during assessments it is essential that the Weed Management Section of DPIW be notified as soon as possible.

Number	Scientific name	Common name	Rank
69.	*Acroptilon repens*	Creeping Knapweed, Hardheads	2
70.	*Bassia scoparia* (= *Kochia scoparia*)	Kochia	2
71.	*Bifora testiculata*	Bifora	2
72.	*Cabomba caroliniana*	Fanwort	2
73.	*Carex albula* (*C. comans*)	Sedge	2
74.	*Carex buchananii*	Sedge	2
75.	*Carex testacea*	Sedge	2
76.	*Cenchrus incertus* (= *Cenchrus pauciflorus*)	Spiny Burrgrass	2
77.	*Cenchrus longispinus*	Spiny Burrgrass	2
78.	*Centaurea calcitrapa*	Star Thistle, Purple Star Thistle	2
79.	*Centaurea eriophora*	Mallee Cockspur	2
80.	*Ceratophyllum demersum*	Hornwort	2
81.	*Chondrilla juncea*	Skeleton Weed	2
82.	*Crupina vulgaris*	Common Crupina, Bearded Creeper	2
83.	*Cuscuta* spp. (excluding *Cuscuta tasmanica*)	Dodder	2
84.	*Cyperus esculentus*	Yellow Nut Sedge	2
85.	*Cyperus rotundus*	Purple Nut Grass	2
86.	*Cytisus multiflorus*	White Spanish Broom	2
87.	*Dittrichia viscosa*	False Yellow Head	2
88.	*Eichornia crassipes*	Water Hyacinth	2

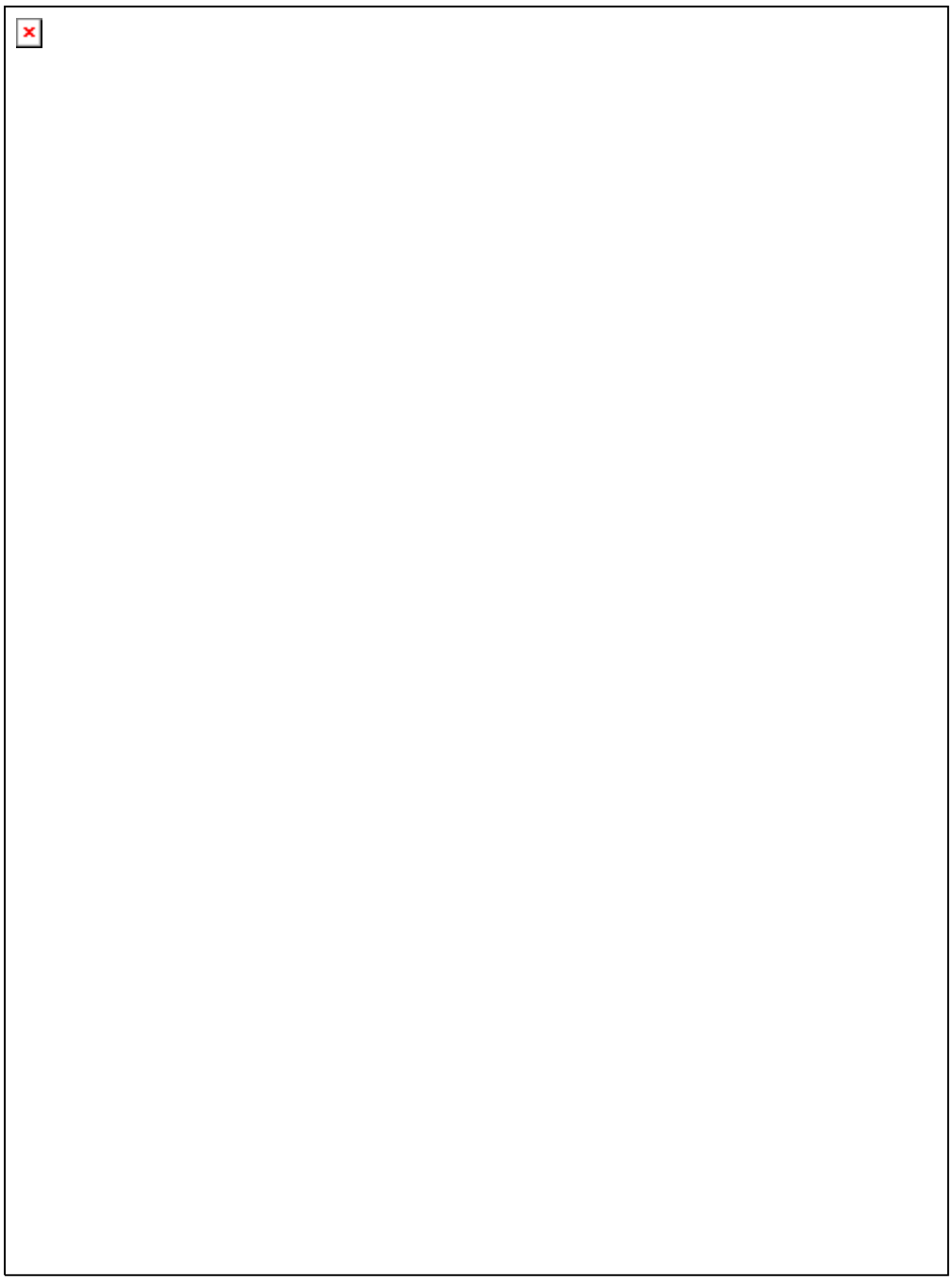
Number	Scientific name	Common name	Rank
89.	*Eleocharis parodii*	Parodi Spike Rush	2
90.	*Festuca gautieri*	Bear-skin Fescue	2
91.	*Galium spurium*	False Cleavers	2
92.	*Galium tricornutum*	Three-horned Bedstraw	2
93.	*Heliotropium europaeum*	Common Heliotrope	2
94.	*Heracleum mantegazzianum*	Giant Hogweed	2
95.	*Hydrilla verticillata*	Hydrilla	2
96.	*Hymenachne amplexicaulis*	Hymenachne	2
97.	*Lagarosiphon major*	Lagarosiphon	2
98.	*Lantana camara*	Lantana	2
99.	*Oenanthe pimpinelloides*	Meadow Parsley, Water Dropwort	2
100.	*Parthenium hysterophorus*	Parthenium Weed	2
101.	*Sagittaria graminea*	Sagittaria	2
102.	*Sagittaria montevidensis*	Sagittaria	2
103.	*Salvinia molesta*	Salvinia	2
104.	*Senecio glastifolius*	Holly-leaved Senecio, Water Dissel	2
105.	*Solanum elaeagnifolium*	Silver-leaf Nightshade	2
106.	*Solanum sodomaeum*	Apple-of-Sodom	2
107.	*Striga* spp. (all non-indigenous species)	Witchweed	2
108.	*Trapa* spp.	Floating Water Chestnut	2
109.	*Tribulis terrestris*	Caltrop	2

APPENDIX V. MAPS OF THE REGIONAL THREAT INDEX.

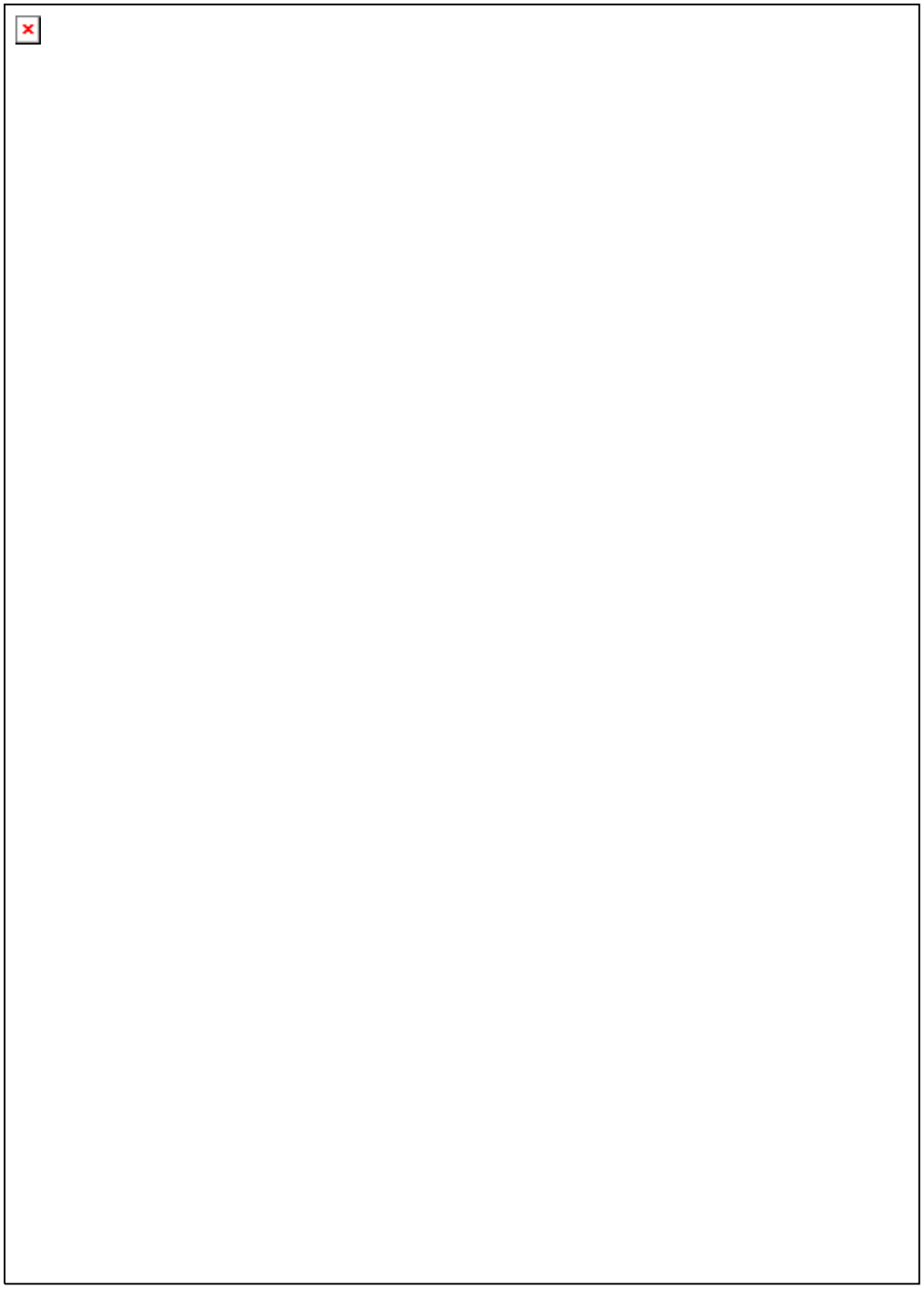
Map 1. Combined RTI scores



Map 2. *Phytophthora cinnamomi* susceptibility



Map 3. Weed risk



Map 4. Grazing risk