# Developing a framework for the conservation of habitat of RFA priority species

# Monitoring the effectiveness of forest management prescriptions for the conservation RFA priority species: current progress and future work

*Milestone 23: Report on the implementation of a program to monitoring the effectiveness of forest management prescriptions (landscape and coupe level) for the conservation of RFA priority species*

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## Disclaimers

The information presented is a broad overview of information considered relevant (by the authors) to the brief. Analysis and discussion has been undertaken to different levels of detail but the coverage of material is necessarily incomplete. We apologise for any errors of fact that may have crept into the report and acknowledge that the unreferenced material presented is based on the opinions and interpretations of the authors.

*Front page photograph:* A view of a managed landscape in southwest Tasmania (A Koch).

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# Glossary

**Adaptive management:** a process of responding positively to change. The term adaptive management is used to describe an approach to managing complex natural systems that builds on common sense and learning from experience, experimenting, monitoring, and adjusting practices based on what was learned.

**Biodiversity:** the variability among living organisms from all sources (including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part). This includes diversity within species and between species and diversity of ecosystems.

**CAR Reserve:** Comprehensive, Adequate and Representative reserve system, as defined in the Tasmanian Regional Forest Agreement 1997.

**Class 4 stream:** as defined by the *Forest Practices Code*, class 4 streams are order 1 and 2 streams that carry water for part or all of the year in most years.

**Coupe:** an area of forest that is planned for timber harvesting as a single unit. It may contain more than one silvicultural objective, such as a number of discrete gaps or clearfells or a combination of both.

**DPIPWE**: Department of Primary Industries, Parks, Water and Environment, which includes the Resources Management and Conservation Division and the Threatened Species Section.

**EPBC Act:** the *Environment Protection and Biodiversity Conservation Act 1999*, which relates to the protection of the environment and the conservation of biodiversity, and for related purposes.

**Forest Practices Authority (FPA):** the independent statutory body responsible for administering the *Forest Practices Act 1985* through the development and management of the forest practices system.

***Forest Practices Code*:** a code established under the *Forest Practices Act 1985* which prescribes the manner in which forest practices must be conducted in order to provide reasonable protection of the environment.

**Forest Practices Officer (FPO)**: FPOs are employed either by forest owners or the forest industry to prepare and supervise the implementation of forest practices plans. They are trained, authorised, directed and monitored by the FPA. Selected FPOs are authorised to certify FPPs.

**Forest practices plan (FPP):** a plan for forest operations, specified in Section 18 of the *Forest Practices Act 1985.* FPPs contain prescriptions and a map detailing how the planned operations will be conducted. FPPs must be consistent with the *Forest Practices Code* and be certified by an FPO before forest operations start.

**Forest Practices System:** the system established pursuant to the objective set out in schedule 7 of the *Forest Practices Act 1985*.

**Forestry Tasmania:** responsible body for management of public land within the forest practices system.

**FPAC:** Forest Practices Advisory Council established under the *Forest Practices Act 1985*.

**Habitat:** the biophysical medium or media (a) occupied (continuously, periodically or occasionally) by an organism or group of organisms; or (b) once occupied (continuously, periodically or occasionally) by an organism, or group of organisms, and into which organisms of that kind have the potential to be reintroduced.

**Habitat tree:** as defined in the *Forest Practices Code*, a habitat tree is a mature living tree selected to be retained in a coupe because it has features of special value for wildlife (e.g. hollows). Habitat trees should be selected on the basis of size and the presence of hollows or the potential to develop hollows over time.

**Land clearing:** the removal and destruction of all native vegetation and vegetation types, including individual trees, woodlands, grasslands, forests and wetlands.

**Biodiversity landscape planning guideline:** a framework for the management of RFA priority species and their habitats at the landscape scale, developed to complete Milestone 19 of the RFA priority species project.

**Native forest:** any naturally occurring forest community containing the full complement of native species and habitats normally associated with that community, or having the potential to develop these characteristics. Native forests include mature, regrowth and regenerating forests.

**Natural Values Atlas (NVA):** a database administered by DPIPWE, with a web-based interface that allows observations of Tasmanian plants and animals to be viewed, recorded and analysed.

**Monitoring:** the regular observation and recording of activities taking place in a project or programme.

**Monitoring – implementation:** monitoring which is used to determine whether prescribed management is actually conducted.

**Monitoring – effectiveness:** monitoring which is used to determine whether the management specified has achieved its objective.

**Old-growth forest:** ecologically mature forest where the effects of unnatural disturbance are now negligible. The definition focuses on forest in which the upper stratum or overstorey is in a late mature to senescent growth stage.

**Planning tool:** an instrument to deliver information to forest practitioners on the management approach for a particular value in areas covered by the forest practices system.

**Prescription:** a detailed specification of the objectives, area, procedures and standards for a task to be undertaken.

**Private land:** a land tenure arrangement where the land is permanently owned and not leased.

**Recovery plans:** wildlife management programs that delineate, justify and schedule management actions necessary to support the recovery of a threatened species or ecological community.

**Reserve – formal:** publically managed land tenures that can only be revoked with parliamentary approval.

**Reserve – informal:** land protected through administrative instruments by public authorities.

**Reserve – private:** private land managed under secure arrangements, including proclamation under legislation, contractual agreements such as management agreements and covenants, and reserves set aside under independently certified forest management systems.

**RFA:** Regional Forest Agreements (RFAs) are 20-year plans, signed by the Australian and certain State governments, for the conservation and sustainable management of certain areas of Australia's native forests.

**RFA Priority Species Project: s**hortened title for Part two of the project titled 'Developing a framework for the conservation of habitat of Regional Forest Agreement priority species and a strategic species plan for the swift parrot (*Lathamus discolor*)' Part 2 – Strategic landscape approach to the management of habitat for RFA priority species.

**Riparian:** pertaining to the banks of streams, rivers or lakes.

**Rotation:** the planned number of years between the establishment of a crop and its felling.

**SAC:** Scientific Advisory Committee established under the *Threatened Species Protection Act 1995*.

**Silviculture:** the theory and practice of managing forest establishment, composition and growth to achieve specified management objectives.

**State forest:** forest on public land which has been designated multiple-use forest by Parliament, under the *Forestry Act 1920*. This land, which includes purchased land, is managed by Forestry Tasmania.

**Stand:** a group of trees or patch of forest that can be distinguished from other groups on the basis of size, age, species composition, condition or other attribute.

**Structure:** when applied to a forest is the vertical and spatial distribution of the vegetation.

**Threatened:** when used in association with a species, population or community indicates that it is listed under the TSP Act 1995 or the EPBC Act 1999.

**Threatened Species Section (TSS):** a section of the Biodiversity Conservation Branch of the Department of Primary Industries Park, Water and Environment (DPIPWE).

**TSP Act:** the Tasmanian *Threatened Species Protection Act 1995,* an Act to provide for the protection and management of threatened native flora and fauna and to enable and promote the conservation of native flora and fauna.

**Threatened Fauna Adviser:** the Threatened Fauna Adviser is a decision-support system developed by the Forest Practices Authority, in consultation with DPIPWE, specialists and the forest industry, to deliver management recommendations for forest-dependant threatened fauna in wood production forests.

# Acronyms

**BACI:** Before After Control Impact

**BBN**: Bayesian Belief Network

**CAR Reserve:** Comprehensive, Adequate and Representative reserve system

**CBS:** clearfell burn and sow (silviculture)

**CFEV:** Conservation of Freshwater Ecosystem Values (catchments)

**CRC:** Cooperative Research Council

**CWD:** coarse woody debris

**DPIPWE:** Tasmanian Department of Primary Industries, Water and Environment

**EPBC Act:** *Environment Protection, Biodiversity and Conservation Act* 1999

**FPA:** Forest Practices Authority

**FPAC:** Forest Practices Advisory Council

**FPO:** Forest Practices Officer

**FPP:** forest practices plan

**GIS**: Geographic Information System

**IBRA:** Interim Biogeographic Regionalisation of Australia

**LiDAR:** Light Detection And Ranging

**NRM:** Natural Resource Management (agency)

**NVA:** Natural Values Atlas

**PI-type:** photograph-interpreted type (information)

**RFA:** regional forest agreement

**SMART:** specific, measurable, achievable and aligned, resourced, and timed

**TFA:** Threatened Fauna Adviser

**TSAC:** Tasmanian Scientific Advisory Council

**TSP Act:** The Tasmanian *Threatened Species Protection Act 1995*

**TSS:** Threatened Species Section (DPIPWE)

**UTAS:** University of Tasmania

**WHS:** wildlife habitat strip

**WHC:** wildlife habitat clump

# Contents

# Monitoring the effectiveness of forest management prescriptions for the conservation of RFA priority species: current progress and future work

## Summary


- This document contributes to the following milestone for Part 2 of the project entitled 'Developing a framework for the conservation of habitat of Regional Forest Agreement priority species and a strategic species plan for the Swift Parrot', being a Schedule signed between the Commonwealth and Tasmanian governments dated Feb 2, 2010 and its variants (referred to in this document as 'The Schedule').

  ***Milestone 23 –*** *Report on the implementation of a program to monitoring the effectiveness of forest management prescriptions (landscape and coupe level) for the conservation of RFA priority species.*

- A myriad of management strategies are applied in areas covered by the Tasmanian forest practices system for the conservation of biodiversity, which includes RFA priority species. Background documents 2 and 3 (Chuter & Munks 2011a, 2011b) reported on these strategies and their implementation. Monitoring the effectiveness of such management strategies and adapting management appropriately is recognised as an integral part of any approach to the conservation of forest biodiversity.

- A summary is provided on four effectiveness monitoring programs conducted by the FPA. Several studies on the distribution, mortality and use of hollow-bearing trees has led to changes in the description of habitat trees and has resulted in a review of the current hollow-management strategy. Monitoring the use of wedge-tailed eagle nests has resulted in changes to the recommended survey techniques, and is stimulating a review of the breeding period. A study of hydrobiid snails is in the early stages but has identified stock control, riparian zone rehabilitation and control of introduced species as potentially important management strategies. A study of wildlife habitat strips has shown that they contribute to the retention of forest structure and late successional species in production landscapes, but that some edge effects occur.

- This document reports on the different types of studies that may be used to monitor the effectiveness of management strategies, including species trend monitoring, habitat surrogate monitoring, forestry impact studies and targeted management studies. All of these approaches have advantages and disadvantages and the most appropriate approach varies with the objective of the study. The type of monitoring needs to be flexible to take into account the inherent complexity of monitoring wildlife and the variety of biodiversity management practices to be evaluated (Munks & Koch 2011).

- This document reports on progress toward the development of a future program to monitor the effectiveness of management actions to achieve the goals of the draft *Biodiversity landscape planning guideline* (Chuter et al. 2011). Development of this program has taken into account the considerations and proposed desirable features identified in the review by Munks and Koch (2011, background document 4). The approach to monitoring the effectiveness of the guideline focuses on GIS analysis whenever possible to maximise efficiency, but also includes field studies. It is not possible to monitor the effectiveness of all management actions, so we outline an

approach for prioritising monitoring programs. This approach identifies the type of action required for each management strategy (refinement of the management strategy, implementation monitoring, effectiveness monitoring or validation monitoring). Within each action group different research projects are prioritised by the importance and effort of the proposed project. The initial implementation of this approach is outlined in the appendix.

# 1 Background

Tasmania has multiple tools and strategies for achieving biodiversity conservation within production forest areas (Chuter & Munks 2011a). The *Forest Practices Code* (Forest Practices Board 2000) contains policies and practices for protecting natural and cultural values, including RFA priority species. These have been developed from a mixture of expert judgement, practical experience and the outcomes of research and monitoring. In addition to existing strategies, a new framework for managing RFA priority species at the landscape scale is currently being developed, known as the *Biodiversity landscape planning guideline* (Chuter et al. 2011).

Two types of monitoring are generally undertaken in forest management, and both are extremely important for determining whether conservation management strategies are working:

- Implementation monitoring (or monitoring of compliance) – used to determine whether prescribed management is actually conducted.
- Effectiveness monitoring – used to determine whether the management specified has achieved its objective and whether the outcome was actually a consequence of management.

The Tasmanian forest practices system follows an adaptive management framework which includes research and monitoring. It is widely recognised that ongoing research and monitoring is important for the scientific credibility of the Code's provisions applied in forest management plans (Commonwealth of Australia and State of Tasmania 1997; Davies et al. 1999; Wilkinson 1999). There is also a legislative requirement to monitor the effectiveness of Code provisions applied in forest practices plans (FPPs). The Tasmanian *Forest Practices Act 1985* states that, 'the Board must…assess the implementation and effectiveness of a representative sample of forest practices plans'. With ongoing public scrutiny of forest practices in Tasmania, the scientific basis for particular management actions needs to be clear.

The biodiversity management strategies delivered under Tasmania's forest practices system and the monitoring conducted to assess their implementation has been reviewed and reported on by Chuter and Munks (2011b). The implementation monitoring program is well established and involves annual reporting of compliance (FPA 2010) and publication of the results of thematic projects (e.g. Munks et al. 2004). The approach to monitoring the effectiveness of the management strategies for biodiversity is less systematic, with many projects initiated in an *ad hoc* fashion in response to management issues.

This current report reviews progress on a number of current and ongoing projects, implemented by the Forest Practices Authority in collaboration with other research providers, which aim to evaluate the effectiveness of management actions for RFA priority species in areas covered by the Tasmanian forest practices system. It also takes the information and recommendations provided in the reviews by Chuter and Munks (2011a, b) and Munks and Koch (2011) and proposes a strategy for the development of a systematic approach to monitoring the effectiveness of management actions for biodiversity in areas covered by the Tasmanian forest practices system. This includes a program for monitoring the effectiveness of the *Biodiversity landscape planning guideline* (Chuter et al. 2011) currently being developed as part of this project.

This report meets milestone 23 for Part 2 of the project 'Developing a framework for the conservation of habitat of Regional Forest Agreement priority species and a strategic species plan for the Swift Parrot', being a Schedule signed between the Commonwealth and Tasmanian governments dated Feb 2, 2010 and its variants.

> ***Milestone 23 –*** *Report on the implementation of a program to monitoring the effectiveness of forest management prescriptions (landscape and coupe level) for the conservation of RFA priority species.*

## 1.1. Report structure

Section 2 of the current document provides a brief report on the progress of four effectiveness monitoring projects conducted to date in areas covered by the forest practices system. It highlights major findings, and how these results have been used to improve management.

Section 3 proposes a strategy for the development of a systematic approach to monitoring the effectiveness of management actions for biodiversity in areas covered by the Tasmanian forest practices system. It includes a brief review of the different types of studies that may be used in effectiveness monitoring with a summary of the advantages and disadvantages of each approach. It also proposes a program for monitoring the effectiveness of the *Biodiversity landscape planning guideline*.

Section 4 provides some general conclusions.

# 2 Current effectiveness monitoring projects

Chuter and Munks (2011b) review the current provisions of the *Forest Practices Code* and associated documents that apply to biodiversity (including RFA priority species). Although there currently is no systematic program for monitoring and reporting on the effectiveness of these provisions, there have been a number of projects initiated in the last 15 years. These projects have arisen primarily in an ad hoc basis, often in response to a particular operational issue, from the sudden availability of opportunistic funds or because of a particular interest of a student or research group. Despite their ad hoc nature these projects have contributed significantly to our understanding of the effectiveness of a number of the actions taken to manage biodiversity in areas covered by the Tasmanian forest practices system.

A brief report is provided here on the progress of four of these effectiveness monitoring projects conducted to date in areas covered by the forest practices system. These summaries highlight major findings, and how the results have been used to improve management. Further details can be found at the Forest Practices Authority website (www.fpa.tas.gov.au).

## 2.1. Maintaining habitat for hollow-using fauna through wildlife habitat clumps

### 2.1.1. Introduction and project aims

Tree hollows provide important habitat for 42 vertebrate species in Tasmania (Koch et al. 2008b) and hollow-using fauna are listed as priority species under the Tasmanian Regional

Forest Agreement. There are some landscape-scale management strategies in Tasmania's production forests that contribute to the retention of tree hollows (e.g. formal and informal reserves). However, the management action specifically prescribed for the maintenance of populations of hollow-using fauna is the retention of small patches of mature forest (wildlife habitat clumps), containing a minimum of 2–3 hollow-bearing trees (Chuter & Munks 2011a; Munks et al. 2009).

Although not clearly stated as such, the current wording of the Tasmanian *Forest Practices Code* implies that the objective of hollow conservation management at the stand level is '... to assist the maintenance of habitat required by hollow dependent fauna and enhance recolonisation of areas following harvest' (Forest Practices Board 2000). While this statement does provide some direction, it is lacking in detail and so does not facilitate the construction of quantitative prescriptions. More information is required about the desired outcome with respect to the species, and the outcome needs to be measurable. A more useful objective has been proposed – 'to ensure a continued supply of hollow-bearing trees at the stand level to assist in the maintenance of populations of hollow-using species across their range' (Biodiversity Review Panel 2009; Munks et al. 2009). The aim should be to maintain breeding populations (not individual numbers) of hollow-using fauna throughout their range in 'off-reserve' areas subject to a variety of anthropogenic land-use practices.

This project was initiated in 1998 to gather information to assess the effectiveness of current management actions for maintaining habitat for hollow-using fauna. The specific aims of the project are:

1. To assess the availability of hollow-bearing trees of use to fauna in the landscape. (What is the availability of the tree hollow resource?)
2. To assess the mortality of retained trees. (Do trees retained in harvested areas survive?)
3. To assess the use of retained trees by hollow-using fauna. (Are the trees retained useful for fauna? Do they aid recolonisation?)

### 2.1.2. Significant results

1. Several studies have been conducted looking at the availability of tree hollows across the Tasmanian landscape. A study in the dry forest in south east Tasmania found that hollow availability varied with tree species, tree form, burn damage, vegetation type, topographic position, stand age and basal area (Munks et al. 2007). A study of felled trees in production forests found that trees are unlikely to contain hollows until they are at least 100 years old, are large in diameter and show signs of senescence (Koch et al. 2008a). A study of hollow availability in wet and dry forest found that remote assessments of mature crown density and, to a lesser extent, tree senescence can reflect changes in relative hollow availability and potentially be used to map the hollow resource (Koch & Baker 2011).
2. A long-term project monitoring wildlife habitat clumps found that tree mortality can be high, due to physical damage, windthrow and fire (Duhig et al. 2000; Koch 2008).
3. A PhD student (L Cawthen) radio-tracked brushtail possums in coupes with wildlife habitat clumps but little regeneration, wildlife habitat clumps with older regeneration, and areas of intact forest. It was found that brushtail possums denned primarily in areas of intact forest when there was little regeneration in the harvested area, but used the wildlife habitat clumps as the harvested areas regenerated (Cawthen unpublished

data; Cawthen 2007). Sites are also being monitored in young plantations to assess the value of retained hollow-bearing trees in plantation landscapes. The initial results have shown that trees vary greatly in the quality of habitat they provide (Koch et al. 2009).

#### 2.1.3. Conclusions and management recommendations

As a result of this work the existing description of habitat trees was deemed inadequate and a booklet was produced to assist with habitat tree identification (Koch 2009). A map predicting potential hollow availability is also under construction. Given the long time required to produce hollows suitable for use by fauna, the high mortality of trees retained within coupes, the specific requirements of many species (not any old hollow will do) and the reluctance of some species to use retained trees for at least a period of time after harvest, it was determined that the way in which hollow-bearing trees are managed in the landscape needs to be reviewed (Biodiversity Review Panel 2009). The assessments of hollow availability and the production of a map reflecting relative hollow availability is allowing a more landscape-scale approach to hollow management to be developed. This approach is currently being trialled by Forest Practices Officers (see Chuter 2011).

## 2.2. The effectiveness of the wedge-tailed eagle habitat management strategy

#### 2.2.1. Introduction and project aims

The Tasmanian wedge-tailed eagle *Aquila audax fleayi* is an RFA priority species and is listed as endangered under state and federal legislation due to a low population size, loss and disturbance of breeding habitat, and high mortality due to persecution and human-related accidents (Mooney 1997). Tasmanian wedge-tailed eagles are considered to be sensitive to disturbance during the breeding season (Mooney 1997), and maintaining viable wedge-tailed eagle breeding populations is an ongoing challenge for land managers.

Management of Tasmanian wedge-tailed eagles in production forest areas is focused primarily on the conservation of nest sites, with a 10 ha reserve placed around any nest tree found, and forestry activities around active nests restricted within a certain distance during the breeding season. Many eagle nests are inactive during the breeding season because eagles maintain several nests within a territory and most pairs do not breed every year. Therefore nests found to be inactive in a particular breeding season may never be used by breeding birds, or may not be used by birds in that particular breeding season. It is therefore important to get an understanding of the factors that influence the use and re-use of a particular nest, and to ensure that the timing of management activities coincides with the timing of eagle breeding.

The overall aim of the current study, initiated in 2007, is to increase our understanding of eagle breeding ecology, and consider the impact of disturbance events occurring in the broader landscape, and thereby evaluate the effectiveness of current management strategies in reducing adverse effects of forestry practices on the breeding success of wedge-tailed eagles (Wiersma 2010; Wiersma et al. 2009).

More specifically, the aims of the study are:

1. To determine whether methods for assessing nest activity are accurate.

2. To determine the timing of breeding events and examine how this varies between years.
3. To examine the rate at which known nests are used and re-used over time.
4. To examine the relationship between nest site characteristics (including degree of disturbance and protection measures) and nest use and success (production of a chick).

#### 2.2.2. Significant results

1. Ground-based surveys of nest characteristics were compared to aerial surveys of nest productivity, showing that a flat top on a nest was the best predictor of nest productivity (with white wash at the nest being the next best predictor) (Wiersma & Koch in press). Flat tops can be difficult to see from the ground.
2. The timing of breeding activity was estimated by using known duration of particular breeding activities and extrapolating from chicks of a known age. In three of the four years of the study, breeding was initiated in June, while in one year breeding was not initiated until July.
3. Over 20% of nests surveyed from the air successfully produced a chick in three of the four years of monitoring (the anomalous year had a very low sample size and low rate of nest success). Most nests surveyed had low rates of re-use; of the 49 nests surveyed during all of the first three years of this study, only one (2%) produced a chick in all three years (Wiersma et al. Unpublished data).
4. A total of 83 nest trees were surveyed from the air for chicks (in at least one year) and were also surveyed from the ground. Successful nests were slightly smaller in diameter and lower to the ground than unsuccessful nests (Wiersma et al. Unpublished data). The relationship between nest success and disturbance in the landscape over a four year study is in the final stages of analysis.

#### 2.2.3. Conclusions and management recommendations

As a result of the current study the techniques for surveying for and assessing the 'activity' of eagle nests have been revised. The breeding period is also under revision, which to some degree affects when forestry activities can be conducted around known nest sites. This study has shown that rates of nest use are low, meaning that non-use in a particular year does not mean that a nest site will not be used by eagles in future seasons. Further recommendations for the improvement of eagle nest management may occur when final modelling results become available.

## 2.3. Maintaining habitat for hydrobiid snails

#### 2.3.1. Introduction and project aims

Forty-one *Beddomeia* species (Mollusca: Hydrobiidae) are listed as either rare, vulnerable or endangered under the Tasmanian *Threatened Species Protection Act 1995* and stream species are 'Priority Species' under the Tasmanian Regional Forest Agreement. *Beddomeia* are small (1 – 6.3 mm) freshwater aquatic molluscs endemic to Tasmania. The genus contains a large radiation of species, most of which are known from only single localities or small

catchments. Limited life-history or distribution information is available for most of the species of *Beddomeia*, although highest population densities of many species occur in the headwaters of small streams. Anthropogenic disturbances including forestry, agricultural practices, mining and impoundment construction are considered threats to *Beddomeia* spp. through modification or loss of habitat (Richards 2010). Management options for areas covered by the forest practices system focus on maintaining habitat quality for populations of *Beddomeia* species throughout their known range, through both strategic planning (ensuring that no more than 15% of the basal area of the forest within the catchment is harvested within a 10 year period), and operational planning (maintaining habitat quality for populations of *Beddomeia* species throughout their known range via extended streamside reserves).

The aim of the current project is to monitor the effectiveness of current management actions on populations of four species identified as high priority for conservation recovery actions (*B. averni, B. fultoni, B. hermansi* and *B. petterdi*) in areas covered by the forest practices system. The specific aims of the project are:

1. To establish population monitoring protocols for four priority *Beddomeia* species.
2. To establish baseline population data of *Beddomeia* across a subset of the known sites including areas where forest practices management actions have and have not been applied.

### 2.3.2. Significant results

1. Monitoring sites for four species of *Beddomeia* have been established and baseline data for three of these species has been collected. Two attempts to gather data for the fourth species have been unsuccessful, due to inaccessibility resulting from high rainfalls.
2. Results of the monitoring program reveal significant subpopulation variation between streams known to contain the species. Evidence was recorded of early stage invasion by the introduced snail *Potamopyrgus antipodarum*, a species which may compete with *Boddomeia* species. Degradation of sites was observed due to removal of riparian vegetation, weed invasion and damage by stock. However young cohorts were found at most sites suggesting populations were currently healthy. Furthermore *B. averni* was found in low densities in pine plantations (Richards, pers. comm.).

### 2.3.3. Conclusions and management recommendations

This study was only recently implemented and so further monitoring is needed to determine the long-term survival prospects of the species at these locations. Results to date suggest that some populations of the *Beddomeia* species surveyed are in peril through competition with *P. antipodarum* and habitat degradation. It is suggested that stock control measures and/or riparian zone rehabilitation is required to improve management of some populations of *B. averni* and *B. hermansi*.

## 2.4. Effectiveness of wildlife habitat strips in maintaining vegetation structure and composition in wet eucalypt forest

### 2.4.1. Introduction and project aims

Wildlife habitat strips (WHS) are corridors of native (uncut) forest that are retained in production forest areas to assist in achieving biodiversity objectives, primarily the maintenance of vegetation composition and structure across the 'off-reserve' landscape. They are prescribed in the Tasmanian *Forest Practices Code* 2000 and, as such, they are a requirement under the Tasmanian *Forest Practices Act 1985*. They are typically 100 meters in width and primarily located along rivers but should also include links up slope and across ridges and maintain connectivity between catchments and formal reserves.

To test the effectiveness of WHS a long-term research project was established in wet eucalypt forest in Tasmania. The specific aim of the project was:

1. To determine whether the floristic composition of vascular flora and forest structure within WHS changes over time if the adjacent areas are logged.

### 2.4.2. Significant results

1. The floristic and structural composition of plots was compared between logged and unlogged (control) sites and between wildlife habitat strips and unlogged (control) sites, using classificatory analysis and ordinations. Results showed that after 12 years the logged coupes were significantly different to control plots in both floristic and structural composition, particularly in the composition of late successional species. WHSs were not significantly different to the control plots, although some edge effects were noted, such as a loss of species sensitive to edges effects (e.g. drying).

### 2.4.3. Conclusions and management recommendations

The study suggests that WHS can fulfil a useful role in maintaining mature forest structure and composition, at least in the short-term, in landscapes subject to intensive forest management. The long-term effectiveness of WHSs may depend on their width and placement in the landscape. Late successional forests should be preferentially retained in production areas where such forests are uncommon.

# 3 A proposed strategy for the development of a systematic approach to monitoring the effectiveness of management actions for biodiversity in areas covered by the Tasmanian forest practices system.

The review of existing national and international effectiveness monitoring projects reported on in Munks and Koch (2011) was the first step in the development of a more systematic approach to effectiveness monitoring. This review highlighted the importance of conducting effectiveness monitoring, and outlined a range of approaches that are used in different areas

by different organisations. It also proposed the following as desirable features of any effectiveness monitoring program adopted in Tasmania:

- *A governance structure involving all stakeholders at national or state-levels (independent monitoring committee).*
- *A clear alignment with management objectives, targets and reporting requirements.*
- *The type of monitoring is tailored to the clarity and scale of the objectives.*
- *A ranking method to prioritise monitoring.*
- *A range of integrated effectiveness monitoring projects with designs that take into account the above considerations.*
- *Use of habitat surrogates and modelling.*
- *A complementary state-level trend monitoring program involving biodiversity and land management agencies (forest management agencies).*
- *Identification of complementary research needs.*
- *An agreed process for reporting, feedback and communication to forest managers and other stakeholders.*
- *Connections to the management decision process should be given high priority early in the development of a program.*

As part of this current project the FPA are developing a framework for the conservation of habitat for RFA priority species. The intent is that the framework will help ensure that the Tasmanian production forest landscape is managed as recommended by current ecological theory to help maintain habitat and manage biodiversity elements, including RFA priority species, at the landscape-scale. Part of this framework is the proposed *Biodiversity landscape planning guideline* (Chuter et al. 2011). The aim of the proposed *Biodiversity landscape planning guideline* is to deliver goals and management targets to meet this intent. The success of such a landscape approach will depend heavily on a rigorous monitoring and reporting of the effectiveness of the actions taken to meet the goals and management targets.

In this section we report on work toward the development of a systematic approach to monitoring the effectiveness of management actions for biodiversity in areas covered by the Tasmanian forest practices system. It includes a brief review of the different types of studies that may be used in effectiveness monitoring, a program for monitoring the effectiveness of the *Biodiversity landscape planning guideline*, and a way of prioritising projects.

## 3.1. Objectives, management targets and actions

The primary objectives of relevant legislation and policies associated with the forest practices system were reviewed during the 2008 review of the biodiversity provisions of the Tasmanian *Forest Practices Code* (Biodiversity Review Panel 2009). Schedule 7 of the *Forest Practices Act 1985* states that the objective of the state's forest practices system is:

> *To achieve sustainable management of Crown and private forests with due care for the environment…*

The review panel noted that this objective may be interpreted as:

> …to maintain Tasmania's native forest and its associated natural and cultural values in areas covered by the forest practices system through sustainable forest use…

Where *sustainable forest use* includes maintaining the ecological processes within forests (the formation of soil, energy flows, and the carbon, nutrient and water cycles), maintaining the biological diversity of forests and optimising the benefits to the community from all uses of forests within ecological constraints (Commonwealth of Australia 1995) and, where *natural and cultural values* includes biodiversity, soil and water, geoheritage, cultural heritage and landscape values.

The proposed *Biodiversity landscape planning guideline* (Chuter et al. 2011) aims to contribute to this overarching objective. The objective of the guideline is to contribute to the maintenance of habitat for biodiversity, including RFA priority species, at multiple spatial scales across the landscape.

Six secondary objectives (i.e. goals) are outlined in the *Biodiversity landscape planning guideline* to meet the overarching objective (Box 1). These goals encompass the structure, resilience or health of the forest system and were established as a result of a review of current ecological theory (Koch et al. 2011). Given the large body of global research that goes into the development of ecological theory, we assume that the link between these goals and maintaining biodiversity is adequately demonstrated in the literature and so is not a high priority for further assessment in Tasmania.

The *Biodiversity landscape planning guideline* links the six goals to management targets which, if achieved, are collectively expected to convey the 'success' of the goal (Box 1). A rationale is provided in the *Biodiversity landscape planning guideline* for how and why these targets help meet the goals and the overarching objective of the forest practices system. These targets focus on habitat availability and quality, rather than biodiversity *per se.*

In the *Biodiversity landscape planning guideline*, each of the management targets is linked to a recommended action and associated planning tools to help planners meet the management target. How well these actions and associated planning tools achieve the management target will be informed by monitoring.

**Box 1. The six goals and associated targets as outlined in the FPA's *Biodiversity landscape planning guideline***

1. Maintain an extensive and permanent native forest estate and avoid or minimise any permanent forest loss
   - 1.1 Maintain forest cover across Tasmania at no less than 95% of the 1996 CRA area
   - 1.2 Maintain 100% or enhance condition of all viable threatened forest communities
   - 1.3 Maintain 75% of the 1996 CRA area or a minimum of 2000 ha (whichever is higher) of non-threatened forest communities in each IBRA bioregion
   - 1.4 Maintain priority vegetation communities that are locally important for conservation
2. Maintain forest structural complexity and landscape heterogeneity
   - 2.1 Maintain seral stage pattern in native forest across the landscape
   - 2.2 Maintain remnant vegetation
   - 2.3 Ensure adequate regeneration in native forest harvest areas, including understorey, within harvest cycle
3. Maintain connectivity of habitat
   - 3.1 Maintain or enhance linkages along water courses and between water courses, capturing a range of habitat types and topographies
4. Maintain the resilience of freshwater ecosystems within the range of natural variation over time
   - 4.1 Maintain water quality and flow
   - 4.2 Maintain lateral and longitudinal connectivity
   - 4.3 Maintain and/or restore riparian vegetation
5. Maintain or improve the health of native habitats
   - 5.1 Manage the risk of introducing weeks or disease into a 'healthy' habitat
   - 5.2 Minimise harmful edge effects on reserves and sensitive vegetation communities
   - 5.3 Manage the risk of genetic pollution in native eucalypt populations and areas of high conservation value
   - 5.4 Maintain soil fertility and structure
6. Maintain or improve the conservation status of forest species, natural levels of genetic diversity and the capacity for adaptability.
   - 6.1 Maintain habitats important for threatened and RFA priority species throughout their range to ensure maintenance of breeding populations.

## 3.2. A review of the types of studies used in effectiveness monitoring and recommended methodology

The reviews of Munks et al. (2010) and Munks and Koch (2011) identified four main types of studies that contribute to effectiveness monitoring both interstate and overseas; species trend monitoring, habitat quality surrogate studies, impact studies and targeted management studies. These all have their advantages and disadvantages, in terms of the information they

provide and how easy or expensive they are to implement (Table 1). In this section of the current report we consider the four types of studies with regard to monitoring the effectiveness of measures delivered via the *Forest Practices Code* to provide reasonable protection for natural and cultural values.

Monitoring species trends is baseline information that is essential for determining the long-term, comprehensive implications of landscape management. Multiple factors can affect species populations and not all factors relate to forest management (e.g. climate change). While it is essential that a holistic view is taken to species management, for many species comprehensive management will be beyond the scope and capacity of the forest practices system alone. Trend monitoring is extremely expensive, and long time frames are required for establishing baseline fluctuations and detecting trends and changes in populations. We therefore argue that examining species trends is a crucial part of a comprehensive effectiveness monitoring, but it is not the highest priority for the Forest Practices Authority (the exception to this may be species with restricted ranges that are wholly located within areas managed by the forest practices system). Instead, we recommend that all organisations in Tasmania involved with managing native biodiversity (including forestry organisations) should establish a coordinated approach to species trend monitoring across the state. Establishing such a program is beyond the scope of the current project.

Monitoring habitat surrogates can be an efficient way of reporting on changes to a forest ecosystem that may have implications for biodiversity. Habitat quality surrogates can include forest cover, forest type, structural elements (e.g. coarse woody debris and tree hollows), amount of roading, fragmentation, soil and leaf nutrition etc. Many of these surrogates have obvious ecological importance and can be easily reported on using current remote-sensing technology (GIS, aerial photos etc). Therefore monitoring habitat surrogates may be a relatively easy and efficient first step for monitoring the effectiveness of biodiversity forest management strategies. However, the importance or impact of some surrogates for biodiversity is uncertain. For example, roads may potentially affect the quality of the habitat for species, but it is not clear which or if populations of species are impacted by the amount of roads in an area. Monitoring could indicate that the amount of roads continues to increase and that roads are therefore a potential management concern. Two alternative responses to the observed increase in roading would be to conduct research to determine whether roads have a negative impact on biodiversity, or revise management on the assumption (or information from the literature) that roads do have a negative effect. Either way, monitoring changes to a habitat quality surrogate like roads helps identify potential management issues by informing us about how the landscape is changing under current management.

Monitoring the direct impact of forestry operations is important for determining if, how and why species are affected by forestry activities. This type of research can lead to modification of silvicultural techniques and the development of management strategies to address direct and indirect negative impacts of harvesting (e.g. loss of habitat or increased predation by feral animals). Examining the impact of forestry operations needs to be done for some species in Tasmania to determine if they are negatively affected by forestry and whether management actions need to be applied. For example some threatened plant species may require disturbance for regeneration and so forestry may have a positive effect and management and landscape-scale monitoring may not be required. However, the small scale at which forestry impact studies are conducted means that they are not a high priority for all species. For example, highly mobile species (e.g. forest birds) may not be found in areas after harvesting (the small scale) but management strategies may be effective in maintaining species across the landscape (the large scale). Examining the direct impact of forestry operations is therefore

a high priority for some species, but is of lower priority for highly mobile species or species where suitable habitat is known to be absent from harvested areas (e.g. tree hollows).

Targeted management studies include a wide range of research or monitoring programs designed to answer specific management questions. These studies may vary greatly in expense, spatial scale, target species etc, depending on the specific objective of the research being conducted. As they are designed to answer specific management questions, targeted management studies facilitate adaptive management more effectively than monitoring species trends or habitat quality surrogates. However, given the wide array of strategies adopted to manage biodiversity in Tasmania's forests, it is not possible (at least in the short-medium term) to establish a comprehensive program to assess all strategies. Therefore an effectiveness monitoring program based on targeted management studies must establish a process for prioritising studies to be undertaken.

Tasmania, like any other region, has limited resources available for monitoring. It is therefore important that any monitoring program established is designed to maximise efficiency and relevance of results. The optimal strategy to adopt will depend on the particular species/ ecosystem/ process/ management strategy being considered. We recommend that a program to monitor species trends be established across the state, but this is a responsibility that should be shared among a number of organisations (and potentially include community participation). We believe that the current focus for the forest practices system should be to monitor habitat quality surrogates and study targeted management strategies, and that an objective process should be adopted to prioritise the studies to be conducted.

In the design of any program, consideration needs to be given to replication (spatial and temporal), control sites and cost.

**Table 1. Four broad approaches to effectiveness monitoring and the advantages and disadvantages of each.**

| Monitoring strategy | Details | Advantages | Disadvantages |
|---|---|---|---|
| Species trend monitoring | • Monitor select species to detect population changes over time<br>• Can focus on common species, and/or species of concern (uncommon species) but optimal sampling may vary with the target species | • Is focusing on the true issue of concern which is species viability<br>• Provides good overview and caters for the impact of all activities in the landscape<br>• Can potentially identify unknown detrimental issues | • Very expensive<br>• Many programs will only have power to detect changes in common species unless designed to target particular species<br>• Reference data is needed so long time periods may be required to detect trends<br>• Does not identify the cause of any changes in species populations (although may be used to develop hypotheses) |
| Habitat quality surrogate studies | • Examine the availability and health of habitat quality surrogates as indicators of ecosystem health, such as forest type, forest structure, tree hollows and coarse-woody debris | • Is addressing some of the causal factors that may affect species<br>• Can be relatively inexpensive, particularly for approaches such as GIS analysis (e.g. of forest edges, changes in availability of mature forest) | • Is an indirect assessment of the health of species and the ecosystem<br>• Requires thorough understanding of the relationship between species and habitat structure, which is not always known, or else assumptions must be made<br>• Assumes habitat availability is the main concern |
| Forestry impact studies | • Detailed studies examining the impact of forestry practices on fauna. May include retrospective studies or studies with a BACI design. | • Will help identify the species most likely to be impacted by forestry activities, and identify how and why they are affected<br>• Cost is variable depending on the species considered and level of replication | • The focus is on the impact of forestry at a small scale, not how effective management practices are at maintaining species in the broader landscape<br>• Does not examine the multiple pressures on a system, and the resilience of the system to these pressures (e.g. climate change) |
| Targeted management studies | • Range of small-scale studies examining particular management practices | • Cost is variable depending on the study<br>• Is directly assessing whether management actions are achieving what they are meant to achieve<br>• Allows prioritisation of the research agenda | • To conduct a comprehensive program assessing all management strategies is time consuming and expensive<br>• Decisions on monitoring priorities may be wrong and so not all impacts may be detected.<br>• May miss landscape patterns unless well designed |

## 3.3. Monitoring the effectiveness of the *Biodiversity landscape planning guideline*, Goals 1 - 6

The aim of any effectiveness monitoring program is to determine whether forest management actions or strategies are successful in meeting their objectives or goals and management targets. Any management action or strategy found to not meet its objective can then be reviewed and revised.

The *Biodiversity landscape planning guideline* proposes 16 management targets which, collectively, are intended to meet the requirements of the six goals and overarching objective. These targets have one or more actions associated with them. These proposed management targets and actions are outlined in Table 2, along with a proposed approach to monitoring how well they are being met (note these proposed targets and actions may change as the *Biodiversity landscape planning guideline* is further developed). A subjective assessment was made as to whether the certainty of achieving the target was high, medium or low, and whether implementation of the proposed monitoring program would take high, medium or low effort (in terms of staff, time and finances).

**Table 2: Proposed management targets, actions and monitoring approach for the *Biodiversity landscape planning guideline*, Goals 1-6**

[a] Certainty of achieving target is a subjective assessment of whether the actions are expected to have a high, medium or low likelihood of achieving the target. High certainty is when we are fairly certain that the actions in place will achieve these targets. Medium is when there is uncertainty as to whether the existing planning tools will result in the actions to achieve the management target. Low is when there is uncertainty as to whether it is possible to achieve the management target.

[b] Effort to monitor is a subjective assessment of whether the proposed monitoring approach requires high, medium or low effort, in terms of both staff time and study cost. High effort is when multiple days are required for field sampling over multiple years, at a substantial financial cost. Medium effort is when it is expected that 4–10 days are required to make the assessment (field or desktop). Low effort is when the assessment is purely a desktop exercise and will take one to three days to complete.

| Management Target | Actions to achieve target | Proposed monitoring approach | Certainty of achieving target [a] | Effort to monitor [b] |
|---|---|---|---|---|
| 1.1 Maintain forest cover across Tasmania at no less than 95% of the 1996 CRA area | No clearing or conversion of forest areas approaching or passing threshold as published on the FPA website | Use GIS techniques to annually monitor native forest cover in Tasmania | M | L |
| 1.2 Maintain 100% or enhance condition of all viable threatened forest communities | No conversion of threatened communities listed under the *Nature Conservation Act 2002* | Use GIS techniques to annually monitor cover of threatened communities in Tasmania | M | L |
| | | Annually monitor FPPs to assess the area of threatened communities cleared during the last financial year. | M | L |
| | Enhancement on a case by case basis following section 6 of the Permanent Native Forest Estate policy and FPAs offset policy | For areas identified for enhancement, establish ground-based measures of habitat quality (based loosely on the habitat hectares approach in Victoria) and monitor at two-yearly intervals (DPIPWE) | M | H |

| Management Target | Actions to achieve target | Proposed monitoring approach | Certainty of achieving target [a] | Effort to monitor [b] |
|---|---|---|---|---|
| 1.3 Maintain 75% of the 1996 CRA area or a minimum of 2000 ha (whichever is higher) of non-threatened forest communities in each IBRA bioregion | No clearing or conversion of forest areas approaching or passing threshold as published on the FPA website | Use GIS techniques to annually monitor cover of non-threatened forest communities in each IBRA region | M | L |
| 1.4 Maintain priority vegetation communities that are locally important for conservation | On public land, maintain areas of priority vegetation communities as identified in attachment 6 of the RFA and listed in the Forest Botany Manual. | Priority vegetation communities are identified in the Forest Botany Manual. FPP cover pages will be assessed annually to determine the amount of priority vegetation converted over the previous year. | M | L |
| 2.1 Maintain seral stage pattern in native forest across the landscape | Limit CBS operations to no more than 15% of the forested area within a CFEV catchment in a 10 year period | Use GIS techniques and information from FPP cover pages to annually assess the area harvested by CBS within catchments. Keep a running record to monitor the area harvested over time. | L | L |
| | Disperse all harvesting operations in space and time | Use GIS techniques (PI-type information and FPPs) to annually identify adjacent areas that have been harvested within the previous five years. May need some on-site verification. | M | M |
| | Do not exceed coupe size of 100 hectares for native forest harvested by clearfelling | Annually examine FPPs for the number of clearfall coupes planned to be over 100 ha in size. Contact land manager to determine final harvested area. | H | L |
| | Maintain 30% mature forest at the mid-scale (planning unit) | Use GIS techniques to annually assess the mature forest context in a 5km radius for each 1km grid square in Tasmania, using the mature habitat | M | L |

| Management Target | Actions to achieve target | Proposed monitoring approach | Certainty of achieving target [a] | Effort to monitor [b] |
|---|---|---|---|---|
| | | availability map. Compare to previous year and identify areas where the context has dropped below 30%, or was below 30% and continues to drop. | | |
| | | Use GIS techniques to annually assess the proportion of mature and regrowth areas in each catchment and each IBRA region, and monitor trends over time. | M | L |
| | | Assess whether stand structure (hollows, CWD, large trees, canopy cover, shrub cover, ground cover) are maintained in the mature forest areas. | M | H |
| 2.2 Maintain remnant vegetation | Maintain or enhance patches of remnant vegetation that are considered high importance for RFA priority species | Annually identify the location of FPPs that involved clearance of remnants. Identify the number of FPPs that involved conversion when less than 20% of the area within a 1km radius was forest. | L | M |
| | | Bi-annually monitor a sample of remnants identified for long-term study, including remnants in agricultural areas, in plantation, in native forest, and areas set aside for rehabilitation as offsets. | L | H |
| 2.3 Ensure adequate regeneration in native forest harvest areas, including understorey, within harvest cycle | Ensure stocking standards achieved in areas regenerated to native forest following harvesting | Annually examine compliance audits to assess the percentage of coupes that meet stocking standards. | H | L |
| | | Compare species diversity and abundance between harvested areas and control (mature) sites. Several examples should be obtained for each type of | H | H |

| Management Target | Actions to achieve target | Proposed monitoring approach | Certainty of achieving target [a] | Effort to monitor [b] |
|---|---|---|---|---|
| | | silviculture used in Tasmania. | | |
| 3. 1 Maintain connectivity of habitat | Maintain or enhance linkages along water courses and between water courses, capturing a range of habitat types and topographies | Annually monitor patch size of forest. Examine if decreases over time. | M | M |
| | | Annually monitor the area of mature forest on ridges, mid-slope or lower slope. Examine if decreases over a 5y period. | M | M |
| 4.1 Maintain water quality and flow | Maintain catchment harvesting thresholds | A catchment harvesting threshold has yet to be established. When a catchment management strategy is established, use FPPs to assess the area due to be harvested that year. Cumulative records will keep a running assessment of the area harvested within the last five years. | L | L |
| | Minimise use of chemicals where there is risk of water contamination due to spray drift | Annually monitor a sample of catchments downstream of young plantations, with paired control sites that do not have plantations. | M | H |
| | Ensure strategic plans and FPP prescriptions protect High Conservation Value CFEV ecosystem units, in conjunction with water management plans where present | High conservation value CFEV ecosystem units need to be identified and located. Annually identify FPPs that overlap with these areas. Examine FPPs to determine whether measures were put in place to protect ecosystem values and whether they were considered adequate. | M | M |

| Management Target | Actions to achieve target | Proposed monitoring approach | Certainty of achieving target [a] | Effort to monitor [b] |
|---|---|---|---|---|
| | In plantation landscapes (>1000 ha in a CFEV sub catchment), limit harvest unit size and disperse harvesting to protect streams and catchments | Identify plantation landscapes using GIS techniques. Monitor the percentage of the catchment harvested in any year. | L | L |
| | | Establish stations to monitor water flow, chemicals and turbidity downstream of plantation landscapes and in adjacent control areas. | L | H |
| 4.2 Maintain lateral and longitudinal connectivity | Consider the placement of wildlife habitat strips and biodiversity spines to provide lateral connectivity between riparian areas and other habitats | Subjectively examine and determine whether WHS and biodiversity spines link riparian areas and other habitats. This is a one-off analysis. | M | M |
| | Maintain riparian zones on streams; increase class 4 stream protection to 10 metre streamside reserve where required for soil and water protection or threatened species management. | Annually examine compliance reports to assess how well riparian zones are retained. | H | L |
| | | Identify threatened species that require 10m reserves on streams. Use GIS analysis to identify existing stream buffers in these areas, and to examine whether FPPs required buffers in these areas. Conduct surveys for threatened species in these and control streams. | H | M |
| 4.3 Maintain and/or restore riparian vegetation | Maintain riparian zones on streams; increase class 4 stream protection to 10 metre streamside reserve where required for soil and water protection or threatened species management. | Annually examine compliance reports to determine if streamside reserves are implemented correctly | H | L |
| | Restore streamside reserves in plantations where land has been previously planted within the | Monitor regeneration and health of riparian vegetation which has been restored in second and subsequent rotation plantations and compare to | M | M |

| Management Target | Actions to achieve target | Proposed monitoring approach | Certainty of achieving target [a] | Effort to monitor [b] |
|---|---|---|---|---|
| | streamside reserve. | control areas in native forest. | | |
| 5.1 Manage the risk of introducing weeds or disease into a 'healthy' habitat | Apply relevant standard *Phytophthora* hygiene measures if the FPP areas contains or is adjacent to:<br>• A highly susceptible forest and/or non-forest community<br>• A susceptible priority species<br>• A susceptible site of significance<br>• A *Phytophthora* Management Area | Assess the implementation of the *Phytophthora* guidelines. Identify areas susceptible to weed and disease invasion. Survey for weeds and *Phytophthora* in a sample of these areas. | L | H |
| | Maintain the *Phytophthora*-free status of quarries | Each year test for the presence of *Phytophthora* in a random sample of areas considered susceptible. | L | M |
| 5.2 Minimise harmful edge effects on reserves and sensitive vegetation communities | For CBS operations maintain a minimum 20 metre buffers of undisturbed native vegetation (where present) adjacent to formal reserves on public land (e.g. national parks, state reserves, forest reserves) and reserves on private land that have been registered on property titles (e.g. reserves established through the private Forest Reserve Program). | Annually conduct a GIS analysis of the PI-type around formal reserves. Assess the proximity of operations near reserves. Sample a random selection of coupes within close proximity and ensure they are further than 20m from a reserve. | M | M |
| | | Using a habitat hectares type approach, assess the health of vegetation at distances from a harvested edge in areas of different forest types | M | H |
| | Maintain a minimum 40 metre buffer (horizontal distance) adjacent to relict rainforest patches. | Establish study sites in areas of relict rainforest. Using a habitat hectares approach assess the health of the community at distances from the edge of the forest. Compare to the health of intact rainforest of similar characteristics | H | H |

| Management Target | Actions to achieve target | Proposed monitoring approach | Certainty of achieving target [a] | Effort to monitor [b] |
|---|---|---|---|---|
| | Maintain a minimum 10 metre machinery exclusion zone around *Sphagnum* communities | Identify study sites in *Sphagnum* areas, some adjacent to areas that have been or will be harvested and some adjacent to or within reserves. Assess the health and cover of Sphagnum at different distances from the edge. Test for edge effects and for an impact of harvesting nearby. Continue monitoring over time. | H | M |
| 5.3 Manage the risk of genetic pollution in threatened native eucalypt species, threatened eucalypt communities and areas of high conservation value (e.g. National Parks). | Develop management and monitoring actions with FPA and UTAS for new hardwood plantations or re-establishing hardwood plantations in areas categorised as high risk for hybridisation. | Identify areas of high risk to hybridisation that are located within 500m of *Eucalyptus nitens* or *E. globulus* plantations of a range of ages. Sample in the area, and in a nearby area at least 100m away from the plantation to identify the level of hybridisation. | L | H |
| | | Where buffers have been applied, assess implementation of buffer and assess hybridisation in area behind the buffer and in a control area. | L | H |
| 5.4 Maintain soil fertility and structure | *The actions and proposed monitoring strategy for this management target are under development* | | | |
| 6.1 Maintain habitats important for threatened and RFA priority species throughout their range to ensure maintenance of breeding populations | *A process for prioritising monitoring programs to meet this management target is outlined in section 3.4 of the current report.* | | | |

## 3.4. Establish monitoring priorities for Goal 6 – Maintain or improve the conservation status of forest species, natural levels of genetic diversity and the capacity for adaptability

It is not possible to monitor everything everywhere at every spatial scale. Monitoring is expensive and time is generally limited so what to monitor needs to be prioritised in a manner that is transparent and comprehensive (Bunnell & Dunsworth 2009; Price & Daust 2009) McComb *et al*., 2010).

The proposed monitoring approach for goals 1–5 in the proposed *Biodiversity landscape planning guideline* are provided in Table 2. However, a method to prioritise monitoring projects for goal 6 is needed because of the large number of RFA priority species and, therefore, the number of management objectives likely to be established. This is also important given the limited resources (time, funds, personnel) available and it is important that monitoring projects are of the highest priority. We propose that the framework outlined by Price and Daust (2009) is used as the basis for prioritising monitoring of any specific actions (over and above those delivered through the landscape planning guideline) applied for RFA priority species (includes threatened species). Although the proposed framework is presented here, the specifics of this prioritisation process are still under development.

### 3.4.1 Establish clear objectives

Numerous strategies are in place for RFA priority species. However, very few of these strategies have clearly-stated objectives, which means that it cannot be determined whether these strategies achieve their intended objective (i.e. are effective). The critical first stage of this part of the effectiveness monitoring program will therefore be to identify the strategies (see Appendix) and outline clear objectives for these strategies. Objectives will be derived from relevant legislation, the *Forest Practices Code* and associated Technical Notes, Recovery Plans, any strategic species plans and from the Threatened Fauna Adviser. Once established, the list of objectives will be circulated to key stakeholders for consideration and feedback. The objectives will then be revised and a final list of objectives will be established.

### 3.4.2 Link threats with management actions

For each objective one or more threats will be identified (only threats that relate to forest practices will be considered). Each threat will be linked to one or more management actions that are believed to potentially reduce or eliminate the threat. A cause-effect link between the threat and the action will be described. These threats and appropriate management have been identified for most species through the recent Threatened Fauna Adviser review.

Attempts will then be made to graph the cause-effect relationship between the threat and the management action, and the uncertainty around this relationship. The graphs will also indicate where current management practices are expected to be on this graph, when relevant management strategies are established (see Appendix 1 for examples). The graphs will largely express only the form of the relationship, and will not be scaled unless empirical data is available to calibrate the graph. The intent of producing these graphs is to facilitate communication between stakeholders, promote rigorous thinking about the relationship between the threat and management action and to propose a hypothesis that can potentially be tested empirically.

The first draft of these graphs will be produced by FPA and TSS staff. Workshops and/or interviews will then be held with relevant experts to refine the graphs. During these workshops/interviews feedback will also be sought on the effort to reduce the uncertainty of the cause-effect relationship, the impact the management approach has on industry and the capacity to adjust management actions if required (Box 2).

**Box 2. Focus for workshops/interviews when establishing monitoring priorities.**

- Graph the cause-effect relationship between proposed threats and actions;
- Discuss the degree and sources of uncertainty about the relationship between threats and actions;
- Discuss the likelihood that monitoring can reduce uncertainty around the cause-effect relationship;
- Discuss the recovery period of each objective;
- Discuss the potential to modify management if actions are found to be ineffective for reducing or eliminating the threat to the objective;
- Discuss the impact of management actions on industry.

### 3.4.3 Determine monitoring priorities

Each threat-action pair will be assessed to determine the type of management/monitoring response that is the highest priority. For threat-action pairs where a clear management strategy is not established, the highest priority will be for **management planning**. For threat-action pairs where it is uncertain if the management action is being applied, the highest priority will be to establish the state of the indicator (i.e. **implementation monitoring**). When management strategies are established and being applied, the threat-action graphs will be reviewed to determine whether the threat-action pair has a priority for **effectiveness monitoring** and/or **validation monitoring** (Table 3). (Validation monitoring is a form of effectiveness monitoring where the priority is to establish a causal link between the action and the threat).

The cause-effect graphs are interpreted by dividing the y-axis of the graphs into three equal size classes; high, medium or low probability of eliminating the threat. The point on the curve that represents the current management requirement is used to determine whether current management is expected to have a high, medium or low probability of successfully eliminating the threat. The uncertainty around this point on the graph will also be examined. Error bands that fall within the one ‘success’ category are classified as having low uncertainty. Error bands that fall within adjacent ‘success’ classes to the best estimate are classified as having medium uncertainty and error bands that cover all three classes have high uncertainty. Graphs which are not based on empirical data will most likely have large error bands and a high level of uncertainty.

The highest priority for effectiveness monitoring, as outlined by Price and Daust (2009), are the threat-action pairs that have a low probability of eliminating the threat and low to moderate uncertainty (Table 3a). That is, the highest priorities are when there is reasonable certainty that a management strategy will not sufficiently reduce the threat in order to achieve the objective. The highest priorities for validation monitoring are the threat-action pairs that

have high uncertainty (Table 3b). That is, the highest priorities are when it is very uncertain whether a management strategy will reduce the threat.

**Table 3. Priorities for (a) effectiveness monitoring and (b) validation monitoring according to the estimated probability of eliminating the threat (i.e. achieving the objective) and uncertainty around this probability. Reproduced from Price and Daust (2009). 1 is the highest priority.**

a) Effectiveness monitoring

| Uncertainty | Estimated probability of eliminating the threat | | |
|---|---|---|---|
| | Low | Medium | High |
| Low | 1 | 2 | 3 |
| Medium | 1 | 2 | 3 |
| High | 2 | 2 | 2 |

b) Validation monitoring.

| Uncertainty | Estimated probability of eliminating the threat | | |
|---|---|---|---|
| | Low | Medium | High |
| Low | 3 | 3 | 3 |
| Medium | 2 | 1 | 2 |
| High | 1 | 1 | 1 |

### 3.4.4 Project prioritisation

Within each of the management/monitoring groups (management planning, implementation monitoring, effectiveness monitoring and validation monitoring) threat-action pairs will be ranked by priority. Initial ranking will be done by examining the tables above. Subsequent ranking will be done by considering the conservation status of the species (i.e. not threatened, rare, vulnerable, endangered) and the 'threat by forestry practices'. For example, the Tasmanian devil is endangered but the threat of forestry alone increasing the conservation status of this species is low. Whereas the wedge-tailed eagle is endangered and the threat of forest practices on its conservation status is high. Ranking may also consider the effort to reduce the uncertainty, the impact of the management on industry, and the ability to change management. Priority will be given to programs with a low effort to reduce uncertainty, a high impact on industry and a high ability to change management actions (Box 3).

**Box 3. Criteria for classifying the effort to reduce uncertainty, impact on industry and ability to change management**

Effort to reduce uncertainty:

High: Multiple days are required for field sampling over multiple years, at a substantial financial cost.

Medium: It is expected that between four and ten days are required to conduct the assessment (field or desktop).

Low: The assessment is purely a desktop exercise and will take between one and three days to complete.

Impact on industry:

High: The management strategy has the potential to stop multiple coupes.

Medium: The management approach has the potential to stop a small percentage of coupes or reduce the area that can be harvested in a large number of coupes.

Low: The management approach is expected to have a small impact on a small number of coupes.

Ability to change management:

A subjective assessment of how easily management strategies could be adjusted, taking into consideration logistics, practicalities and the impact on industry.

High: There is little to no capacity to change management due to legislative restrictions or current conditions in the landscape (e.g. increase habitat for a species with a specialised and localised distribution).

Medium: Changing management strategies would be difficult, but there are no legislative restrictions and the capacity exists within the landscape.

Low: Management strategies could easily be adjusted.

### 3.4.5 Outputs

The output from this process will be a document outlining:

- the management objectives;
- the threats to the management objectives that relate to forestry activities;
- management strategies that can reduce or eliminate the threats;
- a verbal and graphical explanation of the cause-effect links between the objectives, threats and actions;
- an indication of the type of management/monitoring that is the highest priority for each threat;
- a priority ranking for each threat-action pair within each management/monitoring group. Priority rankings are established from the estimated effectiveness of current management, the uncertainty around the estimate and how easily the uncertainty in the relationship can be resolved.

### 3.4.6 Design monitoring projects

After establishment of monitoring priorities, FPA/TSS will prepare a project proposal. The project proposal will outline the design of the monitoring for the highest priority projects, identify personnel for implementing the projects, provide a time line and an approximate budget. The design of each monitoring project will consider:

- spatial scale
- temporal scale
- replication
- species of interest
- sampling methods
- data analysis
- cost
- proposed action given potential outcomes.

The project proposal will be sent to a select group of experts/stakeholders for feedback.

### 3.4.7 Seek funding

While projects will be designed to minimise costs, it is expected that external funding will be required to finance many of the monitoring programs. Funding will be sought from industry, NRM groups, caring for country and other funding agencies.

### 3.4.8 Implement and report

The monitoring programs will be coordinated by FPA and TSS staff, and may include collaborations with students, industry and other researchers. The results will be analysed and reported in a range of places (e.g. Forest Practices News, peer-reviewed journals, training sessions, conference presentations etc.).

## 3.5 Review management

Management strategies applied in areas covered by the forest practices system will be reviewed in light of research outputs. Revisions will be provided to stakeholders for feedback, and then submitted for consideration and comment by the Tasmanian Scientific Advisory Council (TSAC) and the Forest Practices Advisory Council (FPAC) and endorsement by the Board of the Forest Practices Authority. Any changes for management actions for threatened species will also require endorsement by the Secretary of DPIPWE.

## 3.6 Anticipated outputs

An annual report on the effectiveness monitoring program will be produced as part of the annual report of the Forest Practices Authority. Any of the above monitoring programs that indicate the management target is not or may not be met, will stimulate one or more of the following actions:

- assess implementation of the planning tool
- revise planning tool or identify new management priorities
- conduct detailed study to determine the importance or impact of not meeting this management target.

### 3.7 Personnel and governance

The personnel responsible for running the program will largely be FPA staff. However, DPIPWE will take a lead on many of the specific projects relating to threatened species. Some of the programs (e.g. on hybrids or remnants) may be managed primarily by external agencies (e.g. University of Tasmania, Forestry Tasmania).

### 3.8 Budget and financial plan

The majority of these programs are expected to have minimal costs. Where there are more substantial costs involved funds will be sought from other government agencies, industry partners and funding bodies.

## 4. General conclusions

Establishing a program to monitor the effectiveness of the Tasmanian forest practices system is a complex task. There are numerous management strategies that warrant examination, and a range of approaches and types of monitoring that could be used. A prioritisation process is essential to focus any monitoring program in areas where it is most needed. This report outlines a framework for conducting such a prioritisation process and has demonstrated that the Tasmanian forest practices system has the skills and capacity to conduct effectiveness monitoring, and take the adaptive management cycle full circle, using the results of such monitoring to improve management.

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# Appendix: Implementing the proposed effectiveness monitoring approach for Goal 6 of the *Biodiversity landscape planning guideline*

## Context

Section 3.4 of the current document outlines the process for prioritising programs that monitor the effectiveness of management for RFA priority species. The outlined approach requires the identification of objectives, which are then linked to threats and management actions. Research programs can then be developed for the highest priority threat-action relationships. The aim of the appendix is to (1) present some draft case studies for applying the proposed framework and (2) start identifying the management strategies and species that need to be assessed.

## Case studies

Below are two examples of how the proposed prioritisation approach may be applied to threatened species. While details of the approach are provided in Section 3.4, it should be emphasised that the graphed relationships between threats and actions are intended to represent the form of the relationship only; they are not set to scale and are not based on any empirical information. However, if empirical information is available it would be used to calibrate the graphed relationship. It should also be noted that the threats identified are only those threats about which the forest practices system has some capacity to manage. Managing for these threats will not necessarily ensure species persistence. See Section 3.4 for further details.

### Swan galaxiid *Galaxias fontanus*

**Objective:** Maintenance of populations of swan galaxiid across their range, primarily through the maintenance of potential habitat (and known localities). Water quality, flow and condition of riparian vegetation must be protected to help meet this objective. (Source: Threatened Fauna Adviser).

**Threats-Actions pairs:**

1. water flow: area harvested
2. water turbidity: area harvested
3. chemical concentrations in water: distance to chemical application
4. condition of riparian vegetation: streamside reserve widths.

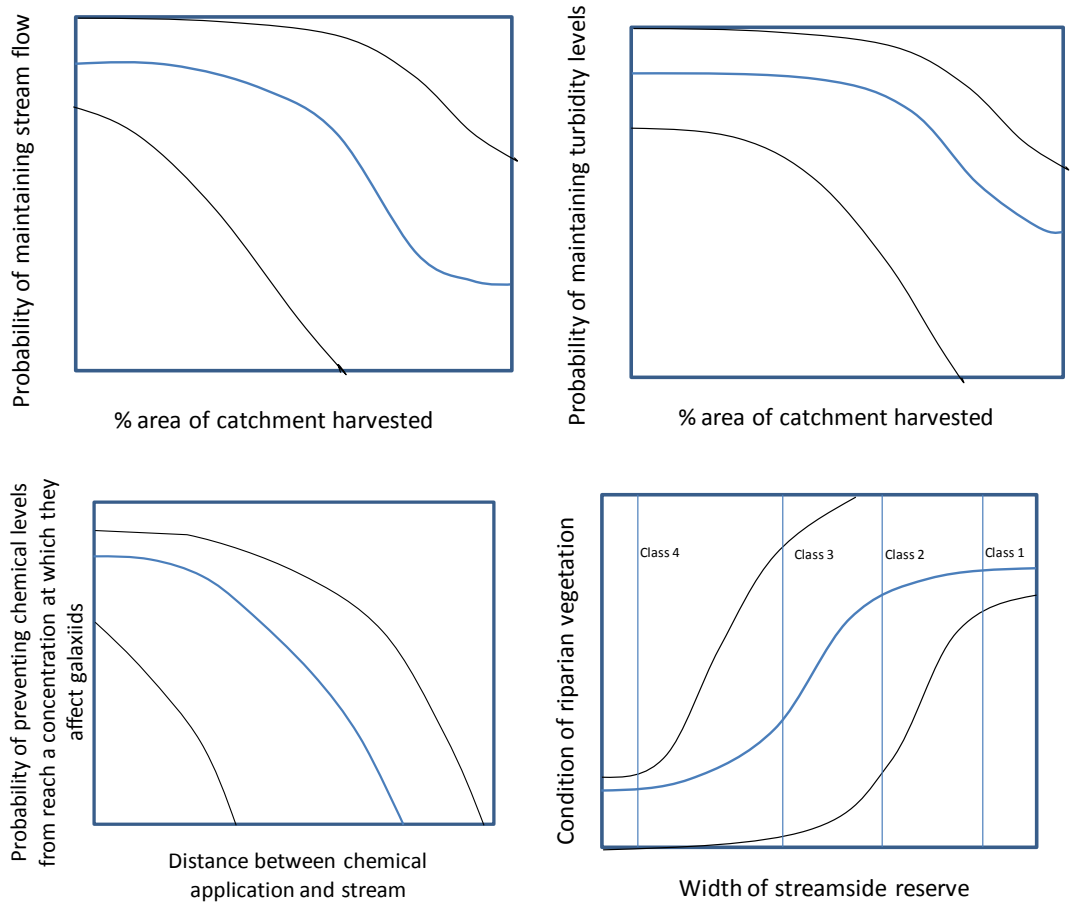


**Figure 1. Assumed relationships between the threats and actions (blue line) with proposed error margins (black lines) and established management thresholds (vertical lines).**

## Rationale:

Changes in water flow are a threat to swan galaxiids in two different ways. Low flow can result in desiccation of habitat in headwater areas. High flow can remove barriers to predators (brown trout). Water flow is strongly affected by climatic conditions over which the forest practices system has no control. Harvesting within a catchment can also impact stream flow regimes and so limiting the harvesting that can occur within a catchment over a particular time frame will limit changes in flow that result from forestry activities.

Water quality may affect the survival and reproductive capacity of swan galaxiids. Harvesting areas within a catchment may affect stream flow and potentially erosion, which in turn affects water quality by increasing turbidity etc. Chemical drift or runoff may enter water systems, potentially having a detrimental effect on galaxiid survival. The likelihood of chemicals enter the water is expected to be related to the distance from the water at which they are applied.

The condition of the riparian vegetation may affect erosion, nutrient input, food availability and stream flow. The width of the streamside reserve is expected to affect the condition of the riparian vegetation.

## Management target:

Generic strategies for management within catchments containing swan galaxiids have yet to be developed. Management strategies should consider levels of harvesting within a catchment that effect stream flow and quality, chemical usage within the catchment and streamside reserve buffers.

**Recommended action:**

Develop management strategies

**Masked owl**

**Objective:** The primary management objective for this species is to implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of known nest sites and potential habitat. (Source: Threatened Fauna Adviser)

**Threat-Action pairs:**

1. Loss of suitable hollows: Maintain mature forest in landscape

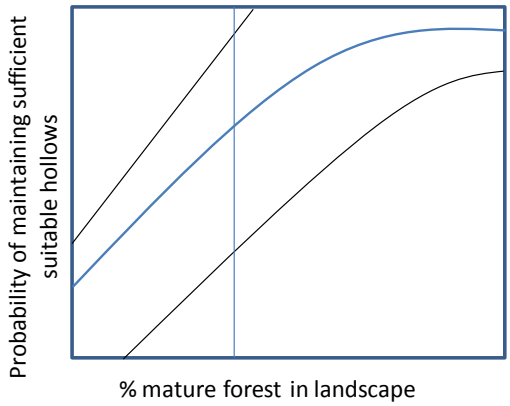


**Figure 2. Assumed relationship between the threats and actions (blue line) with proposed error margins (black lines) and proposed management thresholds (vertical lines).**

**Rationale:**

Masked owls use large tree hollows for both nesting and roosting. Large hollows are only found in old mature trees. Not all hollows are suitable for use, so the amount of mature forest in the landscape should relate to the likelihood that hollows suitable for masked owls are located in the landscape.

**Management target:**

Probability of success: high

Uncertainty: medium

Priority for effectiveness monitoring: low

Priority for validation monitoring: medium

Effort to reduce uncertainty: high

Impact on industry: medium

Ability to change management: medium

**Recommended action:**

Not a high priority for monitoring

**Wedge-tailed eagles**

**Objective:** The primary management objective for this species is to implement actions that will assist the maintenance of breeding pairs of the wedge-tailed eagle throughout its range. (Source: Threatened Fauna Adviser)

**Threat-Action pairs:**

1. Disturbance of breeding pairs at nest: Limit forestry activities within proximity of nest

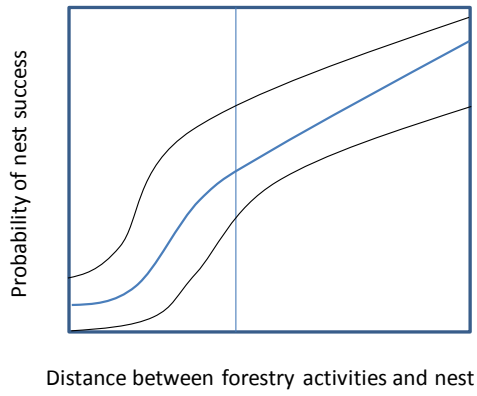


**Figure 3. Assumed relationship between the threats and actions (blue line) with proposed error margins (black lines) and proposed management thresholds (vertical lines).**

**Rationale:**

Wedge-tailed eagles have been shown to be sensitive to disturbance near the nest site, which may result in reduced breeding success. Limiting forestry operations within the proximity of eagle nests should reduce the impact of forestry activities on eagle breeding success.

**Management target:**

Probability of success: medium

Uncertainty: low

Priority for effectiveness monitoring: medium

Priority for validation monitoring: high

Effort to reduce uncertainty: high

Impact on industry: high

Ability to change management: high

**Recommended action:**

Priority for validation monitoring

## Scope of final effectiveness monitoring program

The forest practices system is a complex system that affects biodiversity in many ways. In order to prioritise monitoring programs, it is important to understand the full array of strategies that are being applied. The current section of the report is the first attempt at identifying the species or management strategies that need to be considered. Table 4 outlines the main management strategies in the *Forest Practices Code* that have implications for biodiversity, indicating the biodiversity objectives where available. Attempts at creating a biodiversity objective, identifying threats and management actions (in accordance with the monitoring framework identified in Section 3) have been done for a few of the management strategies.

Table 5 identifies the RFA priority species that need to be considered as part of an effectiveness monitoring program. Many of these species will have specific management requirements that need to be considered as part of the monitoring prioritisation (see the Threatened Fauna Adviser). The section below identifies potential sources of objectives and existing data sources for these species.

Tables 4 and 5 will be completed and refined as part of the implementation of the effectiveness monitoring program.

**Table 4. A summary of management provisions that have implications for biodiversity in Tasmania, including the source of the provision, outlining an objective, threats and management actions where available.**

[a] Note: Biodiversity objectives are adapted from the source specified and do not currently conform with the model for SMART objectives (Koch et al. 2011). Further development of these objectives will be required

[b] *Forest Practices Code*

| Management provision | Source | Biodiversity objectives [a] | Threats | Action |
|---|---|---|---|---|
| Reserves | code[b] | Maintain the genetic resource of native forest | Loss of genetic diversity and species resilience | Use local seed<br>Buffer sensitive areas |
| | | Maintain flora values in formal and informal reserves | | |
| | | Maintain threatened species and inadequately reserved plant communities | | |
| Disperse coupes | code | Maintain landscape heterogeneity to maintain suitable habitat in the landscape | | |
| | | Enhance opportunities for recolonisation of disturbed areas | | |
| | | Maintain species diversity, particularly in extensive plantation areas and other intensively managed areas | | |
| Wildlife habitat strips | code | Maintain habitat diversity | | |
| | | Linking of forest areas to allow genetic interchange | | |
| Wildlife habitat clumps | code | Assist the maintenance of the habitat requirements of oldgrowth dependent fauna species, particularly hollow dependent fauna, | | |
| | | Enhance recolonisation of areas following harvesting | | |
| Special management zones | code | Maintenance and restoration of habitat | | |
| | | Buffering will help protect patches of myrtle or rainforest from fire and myrtle wilt. | Spread of myrtle wilt | Machinery washdown guidelines<br>Buffering of sensitive areas |
| | | | Burning of relict rainforest | Buffering of relict rainforest |
| | | Buffering of native forests to | | |

| Management provision | Source | Biodiversity objectives [a] | Threats | Action |
|---|---|---|---|---|
| | | prevent incursion by adjoining plantation species. | | |
| | | Manage for the requirements of threatened species and communities, aquatic fauna and cave fauna | | |
| Retention and management of native forest remnants | code | To aid the maintenance of local flora and fauna diversity and landscape values | | |
| Machinery washdown | code | Prevent spread of disease and weeds | | |
| Trees should not be felled across localised environments rich in epiphytic species such as relict or oldgrowth rainforest, dense patches of musk or manferns and sheltered boulderfaces. | code | To reduce the intensity of the post-harvest burn such that epiphytic species recover rapidly | | |
| Disturbance to native vegetation in localised environments (such as rocky knolls, swamps, heaths, and streambanks) should be avoided or minimised. | code | Maintain diversity of priority species at a local level | | |
| Minimise the percentage of the catchment harvested in any one year | code | Maintain water quality and flow to maintain suitable habitat for aquatic species | Change in stream flow<br>Change in stream turbidity | % of catchment harvested<br>Streamside reserve width |
| Streamside reserves | code | Maintain water quality and flow to maintain suitable habitat for aquatic and riparian dependent species | Change in stream flow<br>Change in stream turbidity | % of catchment harvested<br>Streamside reserve width |
| | | Protect significant myrtle gullies at risk from myrtle wilt | Spread of myrtle wilt | Width of streamside reserves |
| | | Protect local soil types with high or very high erodibility | | |
| | | Protect fish spawning or nursery areas | | |
| | | Protect areas at significant risk of windthrow | | |
| | | Protect steep areas on rock types | | |

| Management provision | Source | Biodiversity objectives [a] | Threats | Action |
|---|---|---|---|---|
| | | where the landslide threshold angle is exceeded | | |
| Chemical application guidelines | | Maintain water quality to maintain suitable habitat for aquatic species | Change in chemical composition | Distance to stream that chemicals can be applied |
| Forest operations should not result in a significant deviation from natural rates of erosion and landslides | code | | | |
| Control and prevention of nutrient loss | code | | | |
| Control and prevention of excessive compaction | code | | | |
| Control and prevention of mixing of topsoils and subsoils | code | | | |
| Management of karst systems | code | | | |
| Revegetation or surface protection should protect bare soil after operation | code | | | |

**Table 5. A summary of RFA priority species that require management in Tasmania, outlining potential sources of objectives, threats and management strategies.**

| Species | Potential source of objectives, threats and/or management prescriptions | Data source |
|---|---|---|
| **FAUNA** | | |
| *Bettongia gaimardi* Tasmanian bettong | | |
| *Dasyurus maculatus* Spotted-tailed quoll | TFA | |
| *Dasyurus viverrinus* Eastern quoll | | |
| *Lathamus discolor* Swift parrot | *Swift parrot recovery plan 2001–2005*, TFA | |
| *Accipiter novaehollandiae* Grey goshawk | TFA | |
| *Aquila audax fleayi* Wedge-tailed eagle | *Threatened Tasmanian eagles recovery plan 2006–2010,* TFA, *FPA Fauna technical note 1* | |
| *Pardalotus quadragintus* Forty-spotted pardalote | *Forty-spotted pardalote recovery plan 2006–2010*, TFA | |
| *Galaxias fontanus* Swan galaxias | *Tasmanian Galaxiidae recovery plan 2006–2010*, TFA | |
| *Galaxias johnstoni* Clarence galaxias | *Tasmanian Galaxiidae recovery plan 2006–2010*, TFA | |
| *Galaxias tanycephalus* Saddled galaxias | *Tasmanian Galaxiidae recovery plan 2006–2010*, TFA | |
| *Galaxiella pusilla* Dwarf galaxias | *Tasmanian Galaxiidae recovery plan 2006–2010*, TFA | |
| *Antipodia chaostola* Chaostola skipper | TFA | |
| *Prototroctes maraena* Australian grayling | TFA | |
| *Astacopsis gouldi* Giant freshwater lobster | *Giant freshwater lobster recovery plan 2006–2010*, TFA | |
| *Engaeus orramakunna* Mt Arthur burrowing crayfish | *Burrowing crayfish: Engaeus group recovery plan 2001–2005*, TFA | |
| *Engaeus spinicaudatus* Scottsdale burrowing crayfish | *Burrowing crayfish: Engaeus group recovery plan 2001–2005*, TFA | |
| *Engaeus yabbimunna* Burnie burrowing crayfish | *Burrowing crayfish: Engaeus group recovery plan 2001–2005*, TFA | |
| *Geodetrechus mendumae* Cave carabid beetle | | |
| *Geodetrechus parallelus* Cave carabid beetle | | |

| Species | Potential source of objectives, threats and/or management prescriptions | Data source |
|---|---|---|
| *Hoplogonus simsoni* Simson's stag beetle | TFA, *FPA Fauna technical note 11* | Monitoring sites established |
| *Lissotes latidens* Broadtoothed stag beetle | TFA, *FPA Fauna technical note 4*, *FPA Fauna technical note 11* | |
| *Lissotes menalcas* Mt Mangana stag beetle | TFA, *FPA Fauna technical note 5, FPA Fauna technical note 11* | |
| *Miselaoma weldi* Stanley snail | | |
| *Anoglypta launcestonensis* North-east forest snail | | |
| *Beddomeia krybetes* Hydrobiid snail, northeast Tasmania | TFA | Monitoring sites established |
| *Beddomeia tumida* Hydrobiid snail | TFA | Monitoring sites established |
| *Beddomeia spp.* snails | TFA | Monitoring sites established |
| *Phrantela spp.* snails | TFA | |
| *Roblinella agnewi* Land snail | | |
| *Helicarion rubicundus* Burgundy snail | TFA | |
| *Tasmaphena lamproides* Keeled snail | TFA, *FPA Fauna technical note 13* | |
| *Tasmanipatus anopthalmus* Blind velvet worm | TFA | |
| *Tasmanipatus barretti* Giant velvet worm | TFA | |
| *Tasmanotrechus cockerilli* Cave beetle | TFA | |
| *Fraus latistria* Moth | | |
| *Migas plomleyi* Spider | TFA | |
| *Oreixeneca ptunnara* Ptunnara brown butterfly | *Ptunarra brown butterfly recovery plan 1998–2003*, TFA | Phil Bell and Jo Potter |
| *Schayeria bailus* Schayer's grasshopper | | |
| Trichopteran spp. caddis flies | TFA | |
| *Ooperipatellus 'cryptus'* North-west peripatus | | |
| **Other species** | | |
| Hollow dependent species | FPC, *FPA Fauna technical note 7* | |
| Karst species | *Tasmanian alpine karst flora recovery plan 2006–2010*, | |

| Species | Potential source of objectives, threats and/or management prescriptions | Data source |
|---|---|---|
| | TFA | |
| **Species requiring investigation** | | |
| *Accipiter cirrocephalus* Collared sparrowhawk | | |
| *Archipetalia auriculata* Alpine dragonfly | | |
| *Ceyx azure* Azure kingfisher | TFA | |
| *Cryptops n. sp.* undescribed centipede | | |
| *Galaxias auratus* Golden galaxias | *Tasmanian Galaxiidae recovery plan 2006–2010*, TFA | |
| *Haliaeetus leucogaster* White-bellied sea-eagle | *Threatened Tasmanian eagles recovery plan 2006–2010*, TFA, *FPA Fauna technical note 1* | |
| *Lackrana carbo* Geometrid moth | | |
| *Limnodynastes peroni* Perons marsh frog | TFA | |
| *Myiagra cyanoleuca* Satin flycatcher | | |
| *Neiboissoperla n. sp.* Stonefly | | |
| *Neopseudogarypus scutellatus* Pseudoscorpion | | |
| *Nicteria macrocosma* Geometrid moth | | |
| *Paragalaxias mesotes* Arthurs paragalaxias | *Tasmanian Galaxiidae recovery plan 2006–2010*, TFA | |
| *Paralamyctes n. sp*. undescribed centipede | | |
| *Reikoperla n. sp.* stonefly | | |
| *Tasmanophilus n. sp* undescribed centipede | | |
| Undescribed Charopid snail | | |
| **FLORA** | | |
| *Acacia axillaris* | | |
| *Acacia pataczekii* | | Monitoring sites established |
| *Agrostis aemula var. setifolia* | | |
| *Allocasuarina duncanii* | | |

| Species | Potential source of objectives, threats and/or management prescriptions | Data source |
|---|---|---|
| *Alternanthera denticulata* | | |
| *Amphibromus macrorhinus* | | |
| *Anogramma leptophylla* | | |
| *Aphelia gracilis* | | |
| *Aphelia pumilio* | | |
| *Argentipallium spiceri* | | Presumed extinct |
| *Arthrochilus huntianus* | | |
| *Arthropodium minus* | | |
| *Asperula subsimplex* | | |
| *Asplenium hookerianum* | | |
| *Asplenium trichomanes ssp. trichomanes* | | |
| *Austrofestuca hookeriana* | | |
| *Ballantinia antipoda* | | Presumed extinct |
| *Banksia serrata* | | |
| *Barbarea australis* | Barbarea australis *draft flora recovery plan* | |
| *Baumea gunnii* | | |
| *Bertya rosmarinifolia* | | |
| *Blechnum cartilagineum* | | |
| *Bolboschoenus medianus* | | |
| *Boronia rhomboidea* | | |
| *Bossiaea obcordata* | | |
| *Brachyglottis brunonis* | | |
| *Brachyscome radicata* | | |
| *Brachyscome rigidula* | | |
| *Brachyscome sieberi var. gunnii* | | |
| *Brachyscome tenuiscapa var. pubescens* | | |
| *Brunonia australis* | | FPA – Craig Hawkins |
| *Caesia calliantha* | | |
| *Caladenia aff. carnea* "Latrobe" | | |
| *Caladenia aff. catenata* | | |

| Species | Potential source of objectives, threats and/or management prescriptions | Data source |
|---|---|---|
| *Caladenia aff. venusta* | | |
| *Caladenia caudata* | | |
| *Caladenia lindleyana* | | |
| *Caladenia pallida* | | |
| *Callitris* aff. *oblonga* | Eucalyptus ovata–Callitris oblonga *Black Gum/South Esk pine communities recovery plan 2000–2004*, Eucalyptus ovata – Callitris oblonga *forest draft flora recovery plan* | |
| *Calocephalus citreus* | | |
| *Carex bichenoviana* | | |
| *Carex gunniana* | | |
| *Carex longebrachiata* | | |
| *Centipedia cunninghamii* | | |
| *Cheilanthes distans* | | |
| *Chiloglottis trapeziformis* | | |
| *Colobanthus curtisiae* | | |
| *Cryptandra amara* | | |
| *Cyathea cunninghamii* | *FPA Flora technical note 5* | |
| *Cyathea X marcescens* | *FPA Flora technical note 5* | |
| *Cyrtostylis robusta* | | |
| *Danthonia nitens* | | |
| *Danthonia popinensis* | | |
| *Danthonia procera* | | |
| *Desmodium gunnii* | | |
| *Deyeuxia lawrencei* | | Presumed extinct |
| *Deyeuxia minor* | | |
| *Dianella longifolia var. longifolia* | | |
| *Discaria pubescens* | | |
| *Doodia caudata* | | |
| *Dryopoa dives* | | |
| *Ehrharta juncea* | | |
| *Epacris acuminata* | *Forest epacrids recovery plan 1999–2004, Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris aff. exserta* 'Union Bridge' | *Forest epacrids recovery plan 1999–2004, Threatened Tasmanian forest epacrids draft flora recovery plan* | |

| **Species** | **Potential source of objectives, threats and/or management prescriptions** | **Data source** |
|---|---|---|
| *Epacris apsleyensis* | *Forest epacrids recovery plan 1999–2004, Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris curtisiae* | | |
| *Epacris exserta* | *Forest epacrids recovery plan 1999–2004, Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris glabella* | *Forest epacrids recovery plan 1999–2004, Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris grandis* | *Forest epacrids recovery plan 1999–2004, Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris graniticola* | *Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris graniticola* | *Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris limbata* | *Forest epacrids recovery plan 1999–2004, Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris marginata* | | |
| *Epacris stuartii* | Epacris stuartii *recovery plan 1996–2005* | |
| *Epacris virgata* | *Forest epacrids recovery plan 1999–2004, Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris virgata 'Kettering'* | *Forest epacrids recovery plan 1999–2004, Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris virgata sens. strict* 'Beaconsfield' | *Threatened Tasmanian forest epacrids draft flora recovery plan* | |
| *Epacris virgata var. 'autumnalis'* (Sandspit) | *Forest epacrids recovery plan 1999–2004* | |
| *Eryngium ovium* | | |
| *Eucalyptus archeri* | | |
| *Eucalyptus cordata* | | |
| *Eucalyptus morrisbyi* | Eucalyptus morrisbyi *recovery plan 2006–2010* | |
| *Eucalyptus perriniana* | | |
| *Eucalyptus radiata ssp. robertsonii* | FT – management plan | |
| *Eucalyptus risdonii* | | |
| *Euphrasia fragosa* "Southport" | *Threatened Tasmanian lowland* Euphrasia *species recovery plan 2000–2005, Tasmanian lowland* Euphrasia *species draft flora recovery plan* | |
| *Euphrasia gibbsiae spp. psilantherea* | *Threatened Tasmanian lowland* Euphrasia *species recovery plan 2000–2005, Tasmanian lowland* Euphrasia *species draft flora recovery plan* | |

| **Species** | **Potential source of objectives, threats and/or management prescriptions** | **Data source** |
|---|---|---|
| *Euphrasia scabra* | *Threatened Tasmanian lowland* Euphrasia *species recovery plan 2000–2005, Tasmanian lowland* Euphrasia *species draft flora recovery plan* | |
| *Euphrasia semipicta* | *Threatened Tasmanian lowland* Euphrasia *species recovery plan 2000–2005, Tasmanian lowland* Euphrasia *species draft flora recovery plan* | Wendy Potts |
| *Festuca plebeia* | | |
| *Gahnia sieberiana* | | |
| *Glycine latrobeana* | | |
| *Gratiola pubescens* | | |
| *Grevillea australis var. tenuifolia* | | |
| *Gynatrix pulchella* | | |
| *Haloragis aspera* | | |
| *Haloragis heterophylla* | | |
| *Hibbertia calycina* | | |
| *Hibbertia obtusifolia* | | |
| *Hyalosperma demissum* | | |
| *Hydrocotyle laxifolia* | | |
| *Hypolepis distans* | | |
| *Hypoxis vaginata* | | |
| *Isoetopsis graminifolia* | | |
| *Isolepis habra* | | |
| *Isolepis setacea* | | |
| *Isolepis stellata* | | |
| *Juncus amabilis* | | |
| *Juncus vaginatus* | | |
| *Lasiopetalum micranthum* | | |
| *Lepidium hyssopifolium* | | |
| *Lepidium pseudotasmanicum* | | |
| *Lepidosperma tortuosum* | | |
| *Leptorhynchos elongatus* | | |
| *Leucopogon lanceolatus* | | |
| *Lobelia pratioides* | | |
| *Lobelia rhombifolia* | | |

| **Species** | **Potential source of objectives, threats and/or management prescriptions** | **Data source** |
|---|---|---|
| *Lomatia tasmanica* | Lomatia tasmanica *recovery plan 2006–2010* | |
| *Melaleuca pustulata* | | |
| *Micrantheum serpentinum* | | |
| *Mitrasacme divergens* | | |
| *Odixia achlaena* | | FPA –Tim Leaman |
| *Pentachondra ericaefolia* | | |
| *Phebalium daviesii* | Phebalium daviesii *recovery plan 1996–2004,* Phebalium daviesii *draft flora recovery plan* | |
| *Pimelea curviflora var. gracilis* | | FPA – student project |
| *Pimelea filiformis* | | FPA – student project |
| *Pimelea pauciflora* | | |
| *Pneumatopteris pennigera* | | |
| *Poa mollis* | | |
| *Podotheca angustifolia* | | Presumed extinct |
| *Polyscias sambucifolia* | | |
| *Pomaderris elachophylla* | | |
| *Pomaderris oraria* | | |
| *Pomaderris phylicifolia* | | |
| *Prasophyllum aff. fitzgeraldii* "Knocklofty" | | |
| *Prasophyllum aff. odoratum* "Ben Lomond" | | |
| *Prasophyllum milfordense* | | |
| *Prasophyllum milfordense* | | |
| *Prasophyllum robustum* | | |
| *Prostanthera cuneata* | | Presumed extinct |
| *Prostanthera rotundifolia* | | |
| *Pultenaea hibbertioides* | | |
| *Pultenaea hibbertioides* | | |
| *Pultenaea humilus* | | |
| *Pultenaea selaginoides* | | |
| *Rutidosis multiflora* | | |
| *Scaevola aemula* | | |

| Species | Potential source of objectives, threats and/or management prescriptions | Data source |
|---|---|---|
| *Schoenoplectus validus* | | |
| *Schoenus latelaminatus* | | |
| *Scleranthus diander* | | |
| *Scleranthus fasciculatus* | | |
| *Senecio squarrosus* | | Mark Wapstra |
| *Spyridium microphyllum* | | |
| *Spyridium obcordatum* | Spyridium obcordatum *draft flora recovery plan* | |
| *Stenanthemum pimelioides* | | |
| *Stipa bigeniculata* | | |
| *Stipa scabra* | | |
| *Tetratheca gunnii* | | |
| *Thesium australe* | | Presumed extinct |
| *Thismia rodwayi* | | Monitoring sites established |
| *Thryptomene micrantha* | | |
| *Tricoryne elatior* | | |
| *Velleia paradoxa* | | |
| *Veronica notabilis* | | Presumed extinct |
| *Vittadinia cuneata* | | |
| *Vittadinia gracilis* | | |
| *Vittadinia muelleri* | | |
| *Wurmbea latifolia* | | |
| *Xanthorrhoea bracteata* | *Tasmanian threatened grasstrees recovery plan 2006–2010* | |
| **PROPOSED NEW SPECIES** | | |
| *Prasophyllum stellatum* | *Threatened Tasmanian orchids recovery plan 2006–2010* | Monitoring sites established |
| *Pterostylus atriola* | | |
| *Acacia mucronata* subsp. *dependens* | | |