Developing a biodiversity effectiveness monitoring program for the forest practices system: identifying priority projects

Forest Practices Authority, Hobart

Report to the Federal Government and the Forest Practices Authority
Forest Practices Authority Scientific Report 17
October 2013

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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.

Acknowledgements

Thanks to the people who provided discussions on effectiveness monitoring in Tasmania, including Karen Price and Clare Hawkins. Thanks to the people who helped assess current threats and management of threatened species, including Karen Richards, Kevin Bonham, Ray Brereton and Bill Brown. Thanks to Chris Grove for editing the final proof.

Citation

This report should be cited as Forest Practices Authority 2012, *Developing a framework for the conservation of habitat of RFA priority species – Developing a biodiversity effectiveness monitoring program for the forest practices system: identifying priority projects,* report to the Federal Government and the Forest Practices Authority, 20 December 2012, Forest Practices Authority Scientific Report 17.

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.

***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.

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 clearance and conversion: the deliberate process of removing all or most of the native vegetation community from an area of land.

Maintain: To keep at the current state, or at a state which is appropriate for the biodiversity value and/or the context of the landscape so that ecological and/or ecosystem values (including biotic communities and/or biophysical characteristics) are sustained within the range of natural variation over time.

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 program.

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: shortened 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: a decision-support system developed by the FPA, in consultation with DPIPWE, specialists and the forest industry, to deliver management recommendations for forest-dependant threatened fauna in wood production forests.

Acronyms and abbreviations

BLPG: *Biodiversity landscape planning guideline*

CBS: clearfell burn and sow (silviculture)

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

NVA: Natural Values Atlas

PI-type: photograph-interpreted type (information)

RFA: regional forest agreement

SFEFL: Southern Forests Experimental Forest Landscape

SMZ: Special Management Zone

SPIBA: Swift Parrot Important Breeding Area

SSR: streamside reserves

TFA: Threatened Fauna Adviser

TSAC: Tasmanian Scientific Advisory Council

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

TSS: Threatened Species Section (DPIPWE)

WBSE: White-bellied sea-eagle

WHS: wildlife habitat strip

WHC: wildlife habitat clump

WTE: Wedge-tailed eagle

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Summary

- A program to monitor the effectiveness of forest management prescriptions for the conservation of RFA priority species needs to consider all management actions delivered through various mechanisms associated with the *Forest Practices Code* that relate to biodiversity. Monitoring the effectiveness of all these management actions is not achievable in the short to medium term given current resources, and so it is important to prioritise the projects that can be undertaken. This report details the methods and results of the process adopted to prioritise monitoring for (a) the provisions that generally relate to biodiversity, and (b) the provisions that specifically relate to priority species.
- Projects to monitor the effectiveness of forest management actions for general biodiversity were identified using a review of the effectiveness of the code and a report proposing a method for prioritising projects. All projects were assessed and ranked according to the proportion of operations or land area that may be affected, the effort to conduct the monitoring, the expected effectiveness of management, and degree of uncertainty about whether the management action is effective. The highest priority projects, that require targeted monitoring and reporting, include those that consider the effectiveness of measures for catchment management (water flow), maintenance of stand structure heterogeneity (particularly mature forest elements), maintenance of threatened species, habitat availability, control of weeds and disease and recolonisation of harvested areas.
- The process used to identify priority projects to monitor actions for priority species involved identifying threats to species and linking these threats to management recommendations. Each threat-management pair was then assessed in terms of the capacity of the industry to alleviate the threat, importance of the threat to the species, effectiveness of the management action, degree of uncertainty that management is effective, importance of management in alleviating the threat, ability to modify the management action and effort to monitor. The highest priority projects that were 预卅ッ怅预卑ь儀ь币ь斃 o gh this process covered the effectiveness of measures to minimise changes in aquatic habitats for giant freshwater crayfish, fragmentation and loss of habitat for skemps and burgundy snails, loss of breeding habitat for grey goshawks, loss of potential habitat for keeled snails and breeding failure for wedge-tailed eagles.
- During the identification of priority projects it was noted that further management actions and planning tools need to be developed. These include actions for managing biodiversity at the landscape scale, and further actions to manage threats for some threatened fauna.
- Further detail on the priority projects for general biodiversity and for priority species and how they will or are being implemented are reported on in the Implementation Plan (FPA 2012b).
- The top ten projects identified for monitoring the effectiveness of the code provisions are:
    - determine the degree to which the coupe dispersal guidelines limit the amount of harvesting within a subcatchment and thereby reduce impact on water flow

  - determine the degree to which mature habitat availability is changing across the forest estate in Tasmania
  - determine the degree to which the coupe dispersal guidelines limit the amount of harvesting within a subcatchment and thereby reduce impact on water flow
  - determine if the hygiene measures help prevent the spread of *Phytophthora cinnamomi*
  - determine whether significant habitat definitions for threatened species are adequate
  - determine whether WHC help maintain forest birds, hollow users, fungi and bryophytes in forestry areas
  - determine whether the Mature Habitat Availability Map can be used to assess the availability of mature forest features (e.g. hollows and coarse woody debris)
  - determine the degree of connectivity across the state
  - determine whether water quality is maintained in streams under current management
  - determine whether soil productivity is maintained over the long-term by current forestry practices.

- The top ten projects identified for monitoring the effectiveness of the threatened species management provisions are:
  - assess the effectiveness of giant freshwater crayfish management recommendations for managing changes in stream morphology and water quality
  - assess the effectiveness of skemps & burgundy snails management recommendations for managing loss of habitat (wet forest)
  - assess the effectiveness of grey goshawk management recommendations for managing loss of foraging habitat (swamp forest)
  - assess the effectiveness of keeled snail management recommendations for managing loss of potential habitat (wet forest >30yo)
  - assess the effectiveness of skemps & burgundy snails management recommendations for managing loss of habitat (wet forest)
  - assess the effectiveness of wedge-tailed eagle (and WBSE) management recommendations for managing breeding failure due to disturbance
  - assess the effectiveness of grey goshawk management recommendations for managing loss of mature forest structure
  - assess the effectiveness of swift parrot management recommendations for managing insufficient foraging resource to maintain population during the breeding season
  - assess the effectiveness of swift parrot management recommendations for managing insufficient tree hollows to maintain breeding population
  - assess the effectiveness of masked owl management recommendations for managing lack of nest hollows.

1 Background

Effectiveness monitoring is conducted to determine if management actions achieve their objective, and is an essential component of a comprehensive and adaptive management system (Bunnell & Dunsworth 2009; Lindenmayer & Franklin 2002). The importance of effectiveness monitoring is being increasingly recognised, and a range of approaches have been adopted in different areas (Munks et al. 2010; Munks & Koch 2011). Some effectiveness monitoring has been done in Tasmania (Koch et al. 2011, 2012), but forests are complex systems to manage (Bunnell & Dunsworth 2009), new management requirements continue to be identified, and an adaptive management system means that continual review is essential.

Desirable features of any effectiveness monitoring program are:

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

Point 8 is already established for the Tasmanian forest practices system. This current report outlines the methods and results of the process adopted to prioritise an effectiveness monitoring program for the biodiversity provisions (including those for RFA priority species) of the forest practices system, in a way that meets points 1, 2, 3, 4, 5, 7 and 9 above. While a comprehensive effectiveness monitoring program requires trend monitoring (point 6), this is seen as the jurisdiction of DPIPWE (who are currently exploring options for monitoring mammals in Tasmania).

The biodiversity provisions of the forest practices system are delivered through a number of policy documents and planning tools, including:

1. the *Forest Practices Code* and associated Technical Notes
2. the *Biodiversity landscape planning guideline* (a reinterpretation of the strategic provisions of the *Forest Practices Code* that relate to biodiversity)
3. the Threatened Fauna Adviser (delivers management actions for threatened fauna)
4. the *Forest botany manual* (facilitates management actions for flora values including forest communities).

Current information on the effectiveness of the biodiversity provisions of the *Forest Practices Code* was recently reviewed (Koch et al. 2012). This review identified gaps and these were used as the basis for determining priorities for effectiveness monitoring of the *Forest Practices Code*.

A proposed approach for monitoring the *Biodiversity landscape planning guideline* (BLPG) was outlined in Koch et al. (2011) and has been updated for this current report. The *Biodiversity landscape planning guideline* (FPA 2012a) is regarded as a reinterpretation of the code provisions of use in landscape-scale planning, and so the monitoring projects for the code provisions and the BLPG provisions are considered together.

Koch et al. (2011) proposed a way to prioritise the monitoring of goal 6 of the *Biodiversity landscape planning guideline*. Goal 6 is to 'maintain and/or improve the conservation status of forest species, their natural levels of genetic diversity' and actions are largely delivered through the Threatened Fauna Adviser. The approach developed involved establishing clear objectives, linking threats with management actions, determining monitoring priorities, designing monitoring projects, seeking funding and then implementation and reporting. This process has been modified slightly and adopted, as reported below.

The *Forest botany manual* facilitates management actions for different threatened communities and flora species. The *Forest botany manual* enables the identification of species and vegetation communities in different regions of the State. The FPA are working to develop a Threatened Flora Adviser to help with decisions on management actions for RFA priority flora species. Due to current time restrictions we were unable to prioritise the monitoring of threatened flora and vegetation issues. This task will be addressed within the next two years.

Through the prioritisation process a number of issues were identified that do not currently have established management recommendations.

This report meets, in part, milestone 25 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 25 –*** *To review and evaluate the outcomes of the first year of monitoring the effectiveness of forest management prescriptions and the landscape approach to the management of habitat of RFA priority species.*

1.1. Report structure

This report identifies and prioritises effectiveness monitoring projects for two different subsets of biodiversity management under the forest practices system.

Section 2 of the current report details the process, and outcome of the process, adopted to identify priority projects to monitor the effectiveness of general biodiversity provisions (outlined in the *Forest Practices Code* and the *Biodiversity landscape planning guideline*), and the issues that need further management actions.

Section 3 of the current report details the process, and outcome of the process, adopted to prioritise projects to monitor the effectiveness of management for priority species.

Monitoring of both the general biodiversity provisions and targeted management for priority species are important. Consequently, these two sets of monitoring projects are considered separately and no attempt has been made to rank them all together.

Section 4 provides some details on how the monitoring program will be carried out, but this is further expanded on in the implementation plan (FPA 2012b).

2 General biodiversity provisions and goals

2.1. Objectives

To determine whether management actions achieve their objective, it is important to have clear and measurable management objectives.

The statutory objective of the forest practices system is to:

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

A review of the biodiversity provisions of the *Forest Practices Code* was published in 2009 (Biodiversity Review Panel 2009). This review examined the objectives for forest management as published in the *National Forest Policy Statement 1995*, the Tasmanian *Regional Forest Agreement*, the National Forest Policy Implementation Sub-Committee (JANIS), and in the *Forest Practices Code.* After considering these documents and current theory/principles, they proposed a primary and secondary objective for biodiversity conservation in areas covered by the forest practices system (Box 1).

This review of the biodiversity provisions of the *Forest Practices Code* also identified a need for measurable sub-objectives (FPA 2009). Many of the actions required under the *Forest Practices Code* for maintaining biodiversity have very poorly-defined objectives. It is beyond the scope of this project to develop these objectives, but many of the 'General principles' and 'Basic approaches' of the code can be interpreted as aims or objectives (Koch et al. 2012). To facilitate development of effectiveness monitoring projects, the authors of this report interpreted from wording in the code a number of 'sub-objectives' that relate to biodiversity (Appendix 1; It should be noted that these 'interpreted-objectives' were developed solely for the development of an effectiveness monitoring program. Readers should refer to the 'General principles' and 'Basic approaches' of the code when implementing the code.

2.2. Current information on the effectiveness of general biodiversity provisions delivered via the *Forest Practices Code*

A review was recently conducted on the effectiveness of the *Forest Practices Code* (Koch et al. 2012). This review focused on four main impacts forestry could potentially have that would impact biodiversity. These are:

- alteration of forest age structure (reduction in mature habitat and change in age structure heterogeneity)
- alteration of aquatic systems (stream flow, water quality, karst systems)
- impact on soils (soil compaction and displacement, soil productivity)
- habitat fragmentation and the introduction of exotic species.

It was also noted that there could be species-specific impacts not covered by the broad potential impacts identified.

Box 1. The objective and sub-objectives for the Tasmanian forest practices system as proposed by the Biodiversity Review Panel (2009).

The proposed primary objective for biodiversity conservation in areas covered by the forest practices system is:

> '***to maintain biological diversity (biodiversity) across multiple spatial scales—from individual stands to entire regions—through sustainable forest use.***

Where *maintain* means to provide the potential for the elements of biodiversity to survive and continue to evolve in areas covered by the forest practices system.

Where *sustainable forest use* includes maintaining habitat and 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' (Biodiversity Review Panel 2009).

The proposed secondary objective is:

To complement the existing CAR reserve system by applying measures (taking a risk spreading approach and ensuring consistency with effective fire management, silvicultural practice and safety requirements) to:

- *maintain an extensive and permanent native forest estate and avoid or minimise any forest loss*
- *maintain forest stand structural complexity, spatial complexity of habitats (diversity, size and spatial arrangement of habitat patches) and connectivity of habitats*
- *maintain or improve the conservation status of forest species*
- *maintain or improve the health of native habitats*
- *maintain the resilience of freshwater ecosystems within the range of natural variation over time*
- *maintain natural levels of genetic diversity and patterns of differentiation in species*
- *maintain capacity for adaptability of the elements of biodiversity in the face of climate change.*

The main management actions implemented via the forest practices system that relate to the identified impacts are:

- wildlife habitat strips
- wildlife habitat clumps
- coupe dispersal
- streamside reserves
- soil management actions
- remnant management
- karst management
- weed and disease management actions
- species-specific prescriptions.

The conclusions reached regarding the effectiveness of these actions in ameliorating the four main potential forestry impacts are provided in Box 2. In summary, the review found that the effectiveness monitoring that has been done to date is not comprehensive, but the management strategies in place are likely to eliminate or greatly reduce the effect of almost all of the potential impacts. However, most studies conducted have been small scale, limited in duration, and focused on areas that were recently harvested. Little study has been done on the long-term effectiveness of management actions given the spatial and temporal heterogeneity of the impacts.

While the review concluded that the management actions are generally likely to contribute to the maintenance of biodiversity in the production forest landscape, it was acknowledged that there was a high degree of uncertainty in some areas. For example, the effectiveness of the coupe dispersal and karst management provisions were the least certain due to the lack of Tasmania-specific research. Hence this review highlighted the importance of examining the effectiveness of actions for biodiversity at the landscape-scale (Koch et al. 2012).

Since the release of this review document, a report has been released by Forestry Tasmania that outlines the major results of a large-scale SFEFL project in wet forest (Wardlaw et al. 2012). The SFEFL project surveyed vascular plants, flighted beetles and birds in regrowth and mature forest in areas with different contexts of disturbance intensity. The conclusion reached in this report is that the biodiversity in retained mature forest was largely independent of the intensity of disturbance in the surrounding landscape, although the subset of disturbance-sensitive beetles was less species-rich in the most disturbed parts of the experimental landscape. The abundance and species-richness of dense-forest birds, rainforest plants and disturbance-sensitive beetles declined in silvicultural regeneration as the intensity of the landscape disturbance increased (Wardlaw et al. 2012). These results reinforce the need to manage the spatial and temporal heterogeneity of disturbance in the production forest landscape.

Box 2a. Conclusions on the effectiveness of the Tasmanian forest practices system for maintaining biodiversity as stated in the review by Koch et al. (2012)

Alteration of forest age structure

Young and old forests differ in species composition for a variety of taxa so the full range of forest age classes are needed in order to maintain forest biodiversity. Forestry activities can reduce the amount of mature habitat and change the spatial arrangement of age classes.

Studies done have shown that retained areas of mature forest, which include wildlife habitat strips and to a lesser extent wildlife habitat clumps, provide habitat for native species that is more similar to extensive unharvested native forest than harvested areas. Wildlife habitat strips in particular are therefore likely to make an important contribution to maintaining age structure heterogeneity in the landscape, and thereby help maintain forest biodiversity.

However, not all mature-forest dependent species use small retained patches of mature forest when they are located next to recently-harvested areas. The value of retained mature forest (such as wildlife habitat strips) for mature-forest dependent species is expected to increase as the harvested area regenerates, but no data is currently available to assess this.

All studies done to date have assessed the effectiveness of management strategies at a local scale. Wildlife habitat strips are implemented across state forest and so are expected to contribute to age structure heterogeneity and biodiversity maintenance at the landscape-scale. The combination of wildlife habitat strips, coupe dispersal and other measures implemented for different reasons (e.g. streamside reserves), is expected to result in age structure heterogeneity across the landscape (and the limited reporting suggests this is the case). However the scale at which a 'landscape' should be assessed for heterogeneity and the age structure of the landscape that is required to maintain biodiversity is uncertain.

In conclusion, the measures in place help maintain age structure heterogeneity, and therefore biodiversity, but the adequacy of current measures has yet to be examined at the landscape-scale.

Alteration of aquatic systems

The studies examining the effectiveness of streamside reserves are not comprehensive. Most studies have been conducted in wet forest and are short term (two to 15 years after harvest; the effectiveness of reserves for biodiversity may increase as the harvested area regenerates).

Stream morphology and water quality studies have focused on headwater streams, as these were considered most heavily at risk from forestry. Limited work suggests machinery exclusion zones reduce the impact of forestry on class 4 streams, but do not maintain natural values in all class 4 streams 10 years after harvest. (The 'new' class 4 stream guidelines are likely to provide better protection for natural values). The minimal work done on higher order streams indicates that current reserves adequately minimise the direct impacts of harvesting but will only partly mitigate the indirect impacts of harvesting (e.g. changes to stream flow).

Biodiversity studies focused on higher order streams, with wider streamside reserves. Results indicate that streamside reserves will provide habitat for a large proportion of taxa. The value of habitat can vary between riparian and non-riparian areas, meaning that retention needs to also occur in upslope areas. Riparian areas can be greatly edge-effected for some species.

In summary, class 4 streamside reserves will help protect the morphology of many streams and minimise changes in temperature that result from logging, which helps maintain habitat quality for some fauna. Streamside reserves that are 30 m wide appear to protect habitat for most aquatic and terrestrial fauna studied, but even these reserves are entirely edge-effected for some terrestrial fauna like ground-dwelling beetles when the adjacent area is harvested (i.e. for at least five years after harvest). However, despite being edge-effected, 40 m wide streamside reserves provide habitat for most riparian species examined.

Given the lack of research, no conclusions were drawn on the effectiveness of karst management.

Box 3b. Conclusions on the effectiveness of the Tasmanian forest practices system for maintaining biodiversity as stated in the review by Koch et al. (2012)

Impact on soils

The few studies (research and compliance checks) indicate that the impact of forestry on soils is minimal and the code provisions are effective in minimising this impact. The studies to date suggest that the impact on soil productivity is not a concern but the impact of more intensive forestry that may occur in the future is uncertain.

Habitat fragmentation and the introduction of exotic species

Very little work has looked at the degree to which roads increase habitat fragmentation in Tasmania, and the impact this has on native biodiversity. A small number of studies have demonstrated that forestry practices may increase the occurrence of weeds and diseases, but no studies have examined the implementation or the effectiveness of current management. We recommend that this area of research is prioritised.

While studies to date suggest that preservation of remnants is likely to assist biodiversity, the degree to which remnants are retained in forestry areas and therefore the degree to which they help maintain biodiversity in fragmented landscapes is not clear.

Species-specific management

The effectiveness of current management has only been examined for a few species, but the results have been varied. Research has shown that targeted management in forestry areas is not required for some species (e.g. *Odixia*), that management is effective at reducing the impact of forestry on other species (although it may not be certain whether the impact is eliminated, e.g. wedge-tailed eagles) or that management should be adjusted.

2.3. Methods

There are four main types of monitoring to assess the effectiveness of forestry management practices; species trend monitoring, habitat quality surrogate studies, forestry impact studies and targeted management studies (Koch et al. 2011). Each type of monitoring has different advantages and disadvantages and the best approach to adopt will depend on the particular species/ ecosystem/ process/ management strategy being considered. Monitoring species trends is a critical aspect of effectiveness monitoring and is a responsibility that should be shared among a number of organisations but driven by the State environment department (Koch et al. 2011). It has been proposed that monitoring within the forest practices system should focus on habitat quality surrogates and targeted management strategies (Koch et al. 2011).

The review of the effectiveness of the forest practices system biodiversity provisions (Koch et al. 2012) was used as the basis for determining which *Forest Practices Code* provisions should be the focus of a monitoring program (Appendix 1). Projects to monitor the goals of the *Biodiversity landscape planning guideline* were identified in Koch et al. (2011), and have been updated and aligned with the code requirements for the current report (Appendix 1).

For each *Forest Practices Code* or *Biodiversity landscape planning guideline* effectiveness monitoring project we identified a research or monitoring objective and proposed an approach to monitoring. We then assessed:

1) the expected proportion of the area covered by the forest practices system, or proportion of FPPs, to which this management issue applies
2) the expected effectiveness of the management action to meet the objective,
3) our degree of relative certainty/uncertainty about whether the management action is effective, and
4) the effort to conduct the proposed monitoring according to the definitions in Table 1.

The results of this process are outlined in Appendix 1.

Monitoring projects were then sorted by proportion of operations affected (high to low), effort to monitor (lowest to highest), the degree of uncertainty that management is effective (highest to lowest) and management effectiveness (lowest to highest). The results of this process are reported on in the current report and the associated implementation plan. These documents will be sent to stakeholders for feedback, and will be revised as feedback is received.

This review and evaluation process identified a number of additional planning tools required to address management issues not currently covered in the forest practices planning system.

Table 1. Definitions and classifications of the criteria assessed for each of the projects proposed to monitor the effectiveness of the general biodiversity provisions.

Criteria	Definition	Classification		
		High	Medium	Low
Proportion affected	An assessment of the expected proportion of the area covered by the forest practices system, or proportion of FPPs, to which this applies	>70% of area (or FPPs) affected	20–70% of area (or FPPs) affected	<20% of area (or FPPs) affected
Management effectiveness	An assessment about whether the management action is expected to achieve its intended objective	This management action is expected to achieve its intent	This management action is expected to partially achieve its intent	This management action is expected to have little ability to achieve its intent
Degree of certainty/uncertainty management is effective	The confidence in the assessment of management effectiveness	High uncertainty (low confidence)	Medium uncertainty (medium confidence)	Low uncertainty (high confidence)
Effort to monitor	An assessment of the effort required to do the monitoring identified	This is a field project that will take either more than one month within a year, or more than five days annually to perform	This is either an extended (>3 days) one-off desktop exercise, or is a field project that will take between 3 days and a month to establish, but annually or biannually will require only a week or less for extended monitoring	This is a desktop exercise that will take only a few days to perform, and the result can be reported annually

2.4. Results

2.4.1. Additional management tools

The review and evaluation process identified a number of additional management tools needed to help planners meet the general biodiversity provisions of the code and goals of the BLPG.

1. Coupe Dispersal Technical Note
2. Mature Habitat Management Technical Note (currently in draft form)
3. Remnant Technical Note (under development)
4. Catchment Management Approach (under development)
5. Threatened Flora Decision Support Tool (under development).

Preliminary discussions with planners have occurred regarding a Coupe Dispersal Tech Note.

The Mature Habitat Management Technical Note has been drafted and trialled and is currently being considered by the Board of the Forest Practices Authority for endorsement.

The management approach taken in the Remnant Technical Note has been drafted and most of the necessary information required to progress the technical note has been acquired. A draft of this technical note should be available by the end of the 2012–13 financial year.

An approach to developing a catchment management strategy has been discussed by a group of scientists and managers in relation to habitat management for threatened fish. Two main approaches are currently being explored, and are a collaboration between FPA, DPIPWE, FT and a private consultant (P. Davies). Due to the complexities of this management issue, and limitations in access to experts and modelling tools, it is uncertain when a draft of this tool will be available. However, this tool is identified as being high priority and relevant research results will be used in the development of this tool (http://www.fpa.tas.gov.au/research_and_monitoring/biodiversity_program_research_and_monitoring#biores2).

The Threatened Flora Decision Support Tool is an online tool, similar in format to the Threatened Fauna Adviser. This tool is in the early stages of development and is expected to be available by the end of 2013.

2.4.2. General biodiversity priority monitoring projects

The results of the assessment done to identify priority projects to monitor the effectiveness of the general biodiversity provisions delivered via the *Forest Practices Code* and *Biodiversity landscape planning guideline*, are outlined in Appendix 1. (It should be noted that the effectiveness of some aspects of the forest practices system are already reported on in the FPA Annual Report). The assessment has identified monitoring objectives, outlined some proposed methods, and rated the proportion of forested area or FPPs expected to be relevant to this management issue, the expected effectiveness of management, uncertainty of the effectiveness of management, and the effort to monitor. The projects are listed in order of proportion affected (high to low), effort to monitor (low to high), degree of uncertainty that management is effective (high to low) and degree to which management is thought to be effective (low to high), roughly equating to expected gain in understanding for expended effort (Table 2, column 2). These projects have been used to develop an implementation plan which covers project governance, methods, timelines and budget (FPA 2012b).

Table 2. DRAFT objectives and proposed approach for the projects to monitor the general biodiversity provisions, including the proportion affected (PA), an indication of management effectiveness (ME), uncertainty of management effectiveness (UME) and effort to monitor (EM) – ranked as high (H), medium (M) or low (L) as defined in Table 1. (Note: This table contains preliminary results and the inclusion and ranking of projects will change over time as feedback is received from experts and new information or issues arise).

No.	Order	Management issue	Research or monitoring objective	Proposed monitoring approach	PA	ME	UME	EM
1	1	Water flow	Determine the degree to which the coupe dispersal guidelines limit the amount of harvesting within a subcatchment and thereby reduce impact on water flow	GIS techniques will be used to examine the age structure of subcatchments subject to harvesting in Tasmania under the current coupe dispersal guidelines, and this will be related to available models and information on changes in water use with forest age.	H	M	H	L
2	1	Stand structure heterogeneity	Determine the degree to which mature habitat availability is changing across the forest estate in Tasmania	Monitor changes in the distribution of mature habitat over time using the Mature Habitat Availability Map (following testing of the map – see project 14) to determine whether mature features are maintained under current and proposed management approaches.	H	M	H	L
3	2	Water flow	Determine the degree to which the coupe dispersal guidelines limit the amount of harvesting within a subcatchment and thereby reduce impact on water flow	The coupe dispersal guidelines are based on the height of the regenerating forest. To determine if forest height relates to water use, a study will be done looking at the age of the forest at 5 m in height and comparing this to information available on changes in water use.	H	M	H	M
4	2	Weeds and disease	Determine if the hygiene measures help prevent the spread of *Phytophthora cinnamomi*	Stations for monitoring Phytophthora in new roads will be established for long-term monitoring.	H	M	H	M
5	3	Threatened species	Determine whether significant habitat definitions for threatened species are adequate	Collaborate with experts to review habitat definitions and establish spatial layers that can be used to reflect habitat suitability.	H	H	H	M
6	4	Recolonisation	Determine whether WHC help maintain forest birds, hollow users, fungi and bryophytes in forestry areas	Surveys of birds, bryophytes and fungi would be conducted in WHC retained in forestry areas, as well as adjacent areas of intact forest. The species composition of the retained and intact patches would be compared.	H	M	M	M

No.	Order	Management issue	Research or monitoring objective	Proposed monitoring approach	PA	ME	UME	EM
7	4	Stand structure heterogeneity	Determine whether the Mature Habitat Availability Map can be used to assess the availability of mature forest features (e.g. hollows and coarse woody debris)	Survey strip transects for hollows and coarse woody debris in areas mapped as high, medium, low and negligible mature habitat availability.	H	M	M	M
8	5	Habitat connectivity	Determine the degree of connectivity across the state	GIS techniques will be used to determine where formal and informal reserves (including WHS and SSR) are located across the state, the degree to which forested areas are isolated, and to which areas of old forest are isolated.	H	H	M	M
9	6	Water quality	Determine whether water quality is maintained in streams under current management	Long-term monitoring sites will be established in streams in areas of high-intensity forestry, low intensity forestry, and intact forest to evaluate changes in water quality over time.	H	M	L	M
10	7	Productivity	Determine whether soil productivity is maintained over the long-term by current forestry practices	Long-term monitoring sites and/or retrospective studies will be established in areas of high-intensity forestry, low intensity forestry, and intact forest to evaluate changes in productivity over time.	H	H	L	M
11	7	Water quality	Determine whether current management maintains the geomorphology, sediment character and riparian vegetation structure of streams in the long-term	Monitor geomorphology, sediment character and riparian vegetation structure of headwater streams in areas previously (>5y) subject to harvesting under current machinery-exclusion guidelines, and in unharvested areas	H	H	L	M
12	8	Species diversity	Determine whether species diversity is maintained in areas managed through the forest practices system	Conduct biodiversity surveys in landscapes subject to forestry and comparable areas in reserve/relatively undisturbed forest, and conduct species presence and trend monitoring	H	M	M	H

No.	Order	Management issue	Research or monitoring objective	Proposed monitoring approach	PA	ME	UME	EM
13	9	Maintain aquatic systems	Determine whether current SSR management maintains aquatic biodiversity over the long-term	Monitor fish and aquatic invertebrates in streams in areas previously (>5y) subject to harvesting under current management guidelines, and in unharvested areas.	H	H	L	H
14	10	Habitat availability	Assess whether areas designated as offsets can maintain or develop the values that they are offsetting	Establish long-term monitoring plots in offsets as they are being established and assess size and health of the offsets.	M	M	H	M
15	11	Habitat availability	Monitor the health of retained remnants over time	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.	M	L	M	M
16	12	Maintain aquatic systems	Monitor whether aquatic contamination occurs from chemical application in plantations	Annually monitor a sample of catchments downstream of young plantations, with paired control sites that do not have plantations.	M	M	M	M
17	13	Habitat availability	Determine whether buffers help maintain reserve health	Do a Vegetation Condition Assessment to assess the health of vegetation at distances from a harvested edge in areas of different forest types	M	M	L	M
18	13	Weeds and disease	Determine whether buffers for protecting areas of intact forest are effective at minimising the spread of weeds	A study will examine the occurrence of weeds in areas with and without such buffers.	M	M	L	M
19	14	Species diversity	Determine whether epiphytic species richness is maintained in retained areas	Monitor epiphytic species richness in areas retained during harvesting and comparable areas not subject to harvesting. Monitor over time.	M	M	M	H

No.	Order	Management issue	Research or monitoring objective	Proposed monitoring approach	PA	ME	UME	EM
20	15	Threatened species	Determine if threatened flora are maintained in wildlife habitat clumps	The abundance, age structure and health of threatened plants in WHC (applied to manage these threatened plants) would be compared to patches of similar intact habitat and monitored over time.	M	H	M	M
21	16	Recolonisation	Determine how remnant use by fauna changes over time	This study will continue the long-term monitoring of the use of wildlife habitat clumps, paddock trees and small remnants retained in plantation areas, and in adjacent farming land.	M	H	M	H
22	17	Weeds and disease	Determine the extent of myrtle wilt in areas subject to harvesting	Data on the occurrence of myrtle wilt will be collected at a range of sites subject to harvesting. The rates of myrtle wilt will be compared to the data collated by Elliott et al. (2005) before the hygiene measures were applied.	L	L	H	M
23	18	Karst	Determine whether current management guidelines of karst systems maintain abiotic conditions	The abiotic conditions in two karst system will be monitored over time, one system in a subcatchment subject to harvesting and the other in an adjacent subcatchment without harvesting.	L	M	H	M
24	19	Maintain aquatic systems	In areas where streamside reserves are re-established, monitor whether this process was successful	Monitor regeneration and health of riparian vegetation which has been restored in second and subsequent rotation plantations and compare to control areas in native forest.	L	M	M	M
25	20	Habitat availability	Determine whether current management recommendations are effective in maintaining the health of Sphagnum communities	Sphagnum communities adjacent to areas that have been harvested will be compared to similar communities adjacent to or within reserves. The health and cover of Sphagnum will be assessed at different distances from the edge and at different periods after harvesting. The impact of the edge environment and of harvesting will be examined over time.	L	M	M	M

No.	Order	Management issue	Research or monitoring objective	Proposed monitoring approach	PA	ME	UME	EM
26	21	Habitat availability	Determine whether threatened vegetation communities recover after harvesting	Vegetation composition and structure would be examined in harvested and unharvested areas of threatened vegetation communities over time. The change in species composition, level of regeneration and the occurrence of weeds over time would be compared between the harvested and unharvested sites.	L	H	M	M
27	22	Weeds and disease	Determine whether buffers for protecting areas of intact forest are effective at minimising the hybridisation of exotic species	A study will examine the occurrence of hybrids in areas with and without such buffers.	L	M	L	M
28	23	Habitat availability	Determine whether current management recommendations are effective in maintaining the health of relict rainforest	Vegetation Condition Assessments will be done to assess the health of patches of relict rainforest at different distances from the edge of the forest and at different periods after harvesting. The results will be compared to similar data collected from larger patches of intact rainforest.	L	H	L	M

3 RFA priority species provisions

3.1. Objectives

Clear management objectives are a critical element of adaptive management, and effectiveness monitoring programs should align with management objectives (Koch et al. 2011). The first step in the identification of priority RFA species monitoring projects was to identify the objectives for managing RFA priority species.

Management objectives for some species are provided in RECOVERY PLANS and strategic species plans. However, these broad objectives (often aspirational) generally relate to species recovery, which can require actions beyond the scope of the Tasmanian forest practices system.

The Threatened Fauna Adviser (TFA) is a decision-support tool that delivers recommendations on threatened species management to forest planners for activities covered by the Tasmanian forest practices system (Chuter & Munks 2011). The management objectives in the TFA were developed taking into account the context of the forest practices system, and so the TFA objectives are used in this current project. It should be noted, however, that the TFA objectives tend to be broad and generic and need refining for monitoring programs. A summary of management objectives for RFA priority fauna species from the TFA is provided in Appendix 2.

3.2. Methods

A background document produced as part of the 2009–2011 review of the Threatened Fauna Adviser outlines the threats to each species, and provides details on the proposed management strategy (FPA & TSS 2012). This document was produced following extensive consultation with species experts. We used this review to identify the threats to each species relevant to the forest industry. We then considered the management recommendations, and determined which threat(s) each management recommendation address.

We then assessed each threat-management pair against a number of criteria. These criteria, and the classifications used to assess them, are outlined in Table 3. We contacted a range of experts and asked them to review the assessments. FPA staff reviewed any revisions made by experts and, if they disagreed with the recommended changes, the experts were contacted to discuss the results and reach a consensus. The experts contacted and results of the assessment are provided in Appendix 3.

Not all threats to species had management actions delivered via the TFA. For these species and threats it was possible to assess threat importance and the capacity of the industry to alleviate the threat, but no other criteria (Table 3). These species and threats are a priority for the development of management prescriptions (see Appendix 4).

To determine the highest priorities for monitoring we sorted each of the threat-management pairs by:

1. capacity for industry to alleviate threat (highest to lowest)
2. metric of importance (highest to lowest)
3. management importance (highest to lowest)

4. ability to modify management (highest to lowest)
5. effort to monitor (lowest to highest)
6. uncertainty that management is effective (highest to lowest).

The results of the assessment are provided in Appendix 3.

Table 3. Definitions and classifications of the criteria assessed for each threat-management pair.

Criteria	Definition	Definitions		
		High	Medium	Low
Management importance	An expert assessment of the importance a particular management action for alleviating a particular threat.	This is the primary or only management action expected to help alleviate this threat.	This management action is one of several management actions that contribute to alleviating a threat.	This management action is done to make localized contributions to managing a threat, but is not expected to make widespread contributions.
Threat importance	An assessment of the relative importance of this threat for this species and the need for the threat to be managed, based on species ecology.	One of the key processes thought to result in species decline.	One of the key processes limiting population size, or a process suspected to contribute to species decline.	Uncertain if threat has large impact on population or if just affects some individuals.
Management effectiveness	An expert assessment about whether the management action is expected to alleviate the threat.	This management action is expected to totally alleviate this threat for the whole population.	This management action is expected to alleviate this threat in the areas it is applied only, or will help contribute to reducing the impact of this threat but will not eliminate it.	This management action is expected to make only a small contribution to alleviating the impact of this threat.
Degree of certainty/Uncertainty management is effective	The confidence in the assessment of management effectiveness.	High uncertainty (low confidence).	Medium uncertainty (medium confidence).	Low uncertainty (high confidence).
Effort to monitor	A subjective assessment of the effort required to do some monitoring that may help reduce uncertainty or result in changed management. This includes assessing the effectiveness of the planning tools and management recommendations for achieving the desired result, and the effectiveness of the habitat configuration for maintaining the species.	Multiple days are required for field sampling over multiple years, at a substantial financial cost.	It is expected that > four days are required to conduct the assessment, but it can be done within one year.	The assessment will take between one and three days to complete.

Criteria	Definition	Definitions		
		High	Medium	Low
Ability to modify management	A subjective assessment of how easily management strategies could be adjusted (increased), taking into consideration logistics, practicalities and the impact on industry.	Management strategies could easily be adjusted.	Changing management strategies would be difficult, but there are no legislative restrictions and the capacity exists within the landscape.	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).
Impact on industry	A subjective assessment of the impact that increasing the management requirements would have on industry. If there is little capacity to increase management (e.g. management is expected to alleviate this threat), then the impact on industry of further action would be high as proactive management such as rehabilitation would be required.	The management strategy has the potential to stop multiple coupes.	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.	The management approach is expected to have a small impact on a small number of coupes.
Capacity for industry to alleviate threat	The responsibility of the industry to alleviate the threat, related to land tenure of the threatening process, and the relative contribution of industry activities to the threat.	This threatening process is almost completely influenced by industry activities and can be managed by industry.	Industry activities contribute to this threatening process, but other activities also have an impact.	Industry has little to no capacity to manage this threatening process due to land tenure or other factors (e.g. current availability of habitat).
Metric of importance	A metric combining threat importance and management effectiveness to help prioritise the most important threats that are least likely to be well managed.	Threat importance is high and management effectiveness is low or medium. Or threat importance is medium and management effectiveness is low.	Threat importance is high and management effectiveness is high, or threat importance is medium and management effectiveness is medium, or threat importance is low and management effectiveness is low.	Threat importance is low and management effectiveness is high or medium, or threat importance is medium and management effectiveness is high.

3.3. Results

3.3.1. RFA priority species – priority monitoring projects

A summary of the results of the prioritisation process is provided in Appendix 3. The top twenty priorities for monitoring priority species are summarised in Table 4.These projects have been used in the development of an implementation plan which covers project governance, methods, timelines and budget (FPA 2012b).

Table 4. The top 20 priority projects to monitor the effectiveness of actions to meet management objectives for RFA priority species. (Note: This table contains preliminary results and the inclusion and ranking of projects will change over time as feedback is received from experts and new information or issues arise).

ID	Species	Threat	Management	Rank
1	Giant freshwater crayfish	Change in stream morphology and water quality	Increase SSR on high value streams (identified using habitat map)	1
2	Skemps & burgundy snails	Loss of habitat (wet forest)	Apply SSRs on Class 4 streams	1
3	Grey goshawk	Loss of foraging habitat (swamp forest)	No conversion of significant habitat	1
4	Keeled snail	Loss of potential habitat (wet forest >30yo)	Actions in Gunns Woolnorth strategic plan, including implementation of WHSs	1
5	Skemps & burgundy snails	Loss of habitat (wet forest)	Retain 20% of habitat in CBS coupes	2
6	Wedge-tailed eagle (and WBSE)	Breeding failure due to disturbance	No activity within 1k line-of-sight during breeding season	3
7	Grey goshawk	Loss of mature forest structure	Retain 20% mature forest within 1–5k radius	4
8	Swift parrot	Insufficient foraging resource to maintain population during the breeding season	In core range outside SPIBA retain high density foraging and 50% foraging trees in medium/low	4
9	Swift parrot	Insufficient foraging resource to maintain population during the breeding season	In SPIBA retain all high/medium foraging and 50% of foraging in low	4
10	Wedge-tailed eagle (and WBSE)	Breeding failure due to disturbance	Establish a 10ha reserve around known nests	5
11	Keeled snail	Loss of potential habitat (wet forest >30yo)	No conversion of significant habitat	6
12	Swift parrot	Insufficient tree hollows to maintain breeding population	In SPIBAs retain all high and medium density nesting habitat (+90% of nest trees if <30% maturity in SPIBA)	7
13	Swift parrot	Insufficient tree hollows to maintain breeding population	In core range outside SPIBA retain high and medium density nesting habitat (if <30% mature)	7
14	Masked owl	Lack of nest hollows	Retain 30% of landscape as mature habitat	7

15	Swift parrot	Insufficient tree hollows to maintain breeding population	Establish a reserve around known nests	8
16	Burgundy snail	Loss of potential habitat (wet forest all ages)	Restoration of SSRs on all stream classes within plantations	9
17	Cave fauna	Loss or degradation of potential habitat (especially hydrology of caves)	No pesticides or herbicides in feeder streams	10
18	Chaostola & marrawah skippers, hairstreak butterfly	Habitat loss (land clearance)	Retain habitat in WHC s where habitat is patchy	10
19	Grey goshawk	Loss of mature forest structure	No conversion of significant habitat	10
20	Australian grayling	Decline in water quality	Restore riparian veg in plantations	11

4 Implementing

The implementation plan (FPA 2012b) provides detail on how the biodiversity monitoring program for the forest practices system is being and will be implemented. However, a broad summary is provided below.

4.1. Governance

The FPA Research Biologist will be responsible for the implementation and governance of the effectiveness monitoring project as a whole. Feedback on the overall program will be sought from other FPA staff, industry personnel and DPIPWE, including feedback on project priorities, study objectives, study design, and outputs. Depending on the particular project, feedback will also be sought from species experts and university staff.

Some of the projects will and are being implemented by agencies other than the FPA (e.g. DPIPWE, FT or university). Under these circumstances FPA staff will provide feedback and support if and as appropriate.

The people involved with actually conducting the research are likely to vary according to the project, and may include FPA staff, university students, industry personnel and other government agencies.

4.2. Funding

FPA resources for conducting research and monitoring are currently limited. The projects with lower budgets are therefore most likely to be implemented in the near future under current resources. However, the FPA Research Biologist and FPA Biodiversity Manager will seek funding and collaborators to support the larger projects. In addition, students will be sought to conduct some of the priority research projects.

4.3. Reporting and communication

An update on the effectiveness monitoring program will be included in all future editions of the FPA Annual Report. This report will be brief, and for projects that are more involved a report will be produced and made available on the website. For suitable projects the results will also be written up into scientific publications and /or presented at scientific conferences. The reports and publications will be sent to relevant stakeholders for feedback.

Reporting on the effectiveness monitoring program will meet the requirements of the:

- state of the forests reporting
- procedures agreed between DPIPWE and FPA for the management of Threatened species in areas covered by the forest practices system
- annual report of the FPA
- biodiversity review recommendations.

4.4. Adaptive management

The results of the monitoring program will be used to inform the ongoing review of management strategies following the agreed process (Appendix 5). This monitoring program and the priority projects will be reviewed and updated annually as part of the FPA annual review.

5 References

Biodiversity Review Panel 2009, *Review of the biodiversity provisions of the Tasmanian Forest Practices Code*, Unpublished report to the Forest Practices Authority, Hobart.

Bunnell, FL & Dunsworth, GB 2009, *Forestry and Biodiversity. Learning how to sustain biodiversity in managed forests*, UBC Press, Vancouver, Canada.

Chuter, A & Munks, SA 2011, *Developing a framework for the conservation of habitat of RFA priority species – Background Report 2. A review of the approach to the conservation of RFA priority species in areas covered by the Tasmanian Forest Practices System*, Forest Practices Authority, Hobart, Tasmania.

Elliott, HJ, Hickey, JE & Jennings, SM 2005, 'Effects of selective logging and regeneration treatments on mortality of retained trees in Tasmanian cool temperate rainforest', *Australian Forestry*, vol. 68, no. 4, pp. 274–80.

FPA 2009, *Summary of recommendations made in the review of the biodiversity provisions of the Tasmanian Forest Practices Code*, Forest Practices Authority, Hobart.

---- 2010, *Interim species habitat planning guideline for the conservation management of Lathamus discolor (Swift Parrot) in areas regulated under the Tasmanian Forest Practices System*, Internal report to the Forest Practices Authority, Hobart.

---- 2012a, *Biodiversity Landscape Planning Guideline: A framework for the management of RFA priority species and their habitats at the landscape scale*, Forest Practices Authority, Hobart.

---- 2012b, *Forest Practices Authority effectiveness monitoring implementation plan*, Forest Practices Authority, Hobart.

FPA & TSS 2012, *Review of Threatened Fauna Adviser: Background Document 2. Review of information on species and management approach*, Forest Practices Authority and Threatened Species Section (DPIPWE), Hobart.

Koch, AJ, Chuter, A & Munks, SA 2011, *Developing a framework for the conservation of habitat of RFA priority species – Background report. Effectiveness monitoring in Tasmania: a summary of current progress and future work*, Forest Practices Authority, Hobart.

---- 2012, *IVG forest conservation report 10. A review of forestry impacts on biodiversity and the effectiveness of 'off-reserve' management actions in areas covered by the Tasmanian forest practices system*, Forest Practices Authority, Hobart.

Lindenmayer, DB & Franklin, JF 2002, *Conserving Forest Biodiversity. A comprehensive multiscaled approach*, Island Press, Washington DC.

Munks, SA, Kavanagh, RP & Loyn, RH 2010, *Monitoring the effectiveness of forest practices to conserve biodiversity in western North America: lessons for Australian forest management*, A report to the Max Jacobs Fund Committee, the Forest Practices Authority, Tasmania, the Department of Industry and Investment, New South Wales and the Arthur Rylah Institute, Victoria, Hobart.

Munks, SA & Koch, AJ 2011, *Developing a framework for the conservation of habitat of RFA priority species – Background Report 4. A review of approaches used interstate and overseas to monitor the effectiveness of forest management prescriptions for the conservation of biodiversity.*, Forest Practices Authority, Hobart, Tasmania.

Swift Parrot Recovery Team 2010, *Background document – National Recovery Plan for the Swift Parrot Lathamus discolor*, Department of Environment , Climate Change and Water and Birds Australia, Queanbeyan.

Wardlaw, T, Grove, S, Balmer, J, Hingston, A, Forster, L, Schmuki, C & Read, S 2012, *Persistence of mature-forest biodiversity elements in a production-forest landscape managed under a Regional Forest Agreement*, Forest and Wood Productions Australia, Hobart.

Appendix 1: Monitoring projects required to assess the effectiveness of the general biodiversity provisions

A recent review highlighted the lack of clear objectives for biodiversity in the *Forest Practices Code* (Biodiversity Review Panel 2009). Clear objectives are needed to determine whether management is meeting its objective. Consequently, the authors used the wording of the code to interpret the intent of management that relates to biodiversity, as per Table 5. (Note: these interpreted-objectives are only for the purposes of setting up this effectiveness monitoring program and all other users should refer to the direct wording in the code). These interpreted-objectives are necessarily broad given the current wording of the code and provide only limited guidance (e.g. on the spatial and temporal extent to which the objectives apply).

A review of current information available on the effectiveness of the *Forest Practices Code* was conducted in 2012 (Koch et al. 2012). This review was used as the basis for determining the effectiveness monitoring requirements for each of the interpreted-objectives of the code, as outlined in Table 5.

Table 5. An interpretation of the management objectives of the *Forest Practices Code* that relate to biodiversity, with a summary of the requirement for effectiveness monitoring.

Code provision	Code 'interpreted-objectives' [a]	Effectiveness monitoring requirement [b]
D1	Minimise erosion	Monitored through compliance assessments. [c]
	Minimise landslides	Monitored through compliance assessments. [c]
	Prevent excessive nutrient loss	Literature suggests not major concern but requires monitoring.
	Prevent excessive compaction, puddling and mixing of topsoils and subsoils	Monitored through compliance assessments. [c]
D2	Maintain water quality	Previous work suggests current standards may be effective, but further monitoring required.
	Maintain water flow	A catchment management approach needs to be developed. Catchments with large plantation areas are of the greatest concern. Coupe dispersal guidelines expected to help mitigate but monitoring is required.
	Maintain catchment and channel stability	Impact expected to be minimal under current management, but monitoring required.
	Maintain biodiversity in aquatic ecosystems	Streamside reserves provide habitat for a range of terrestrial fauna and help maintain populations of aquatic fauna. Reserves at least 30m wide were most effective. Most work has been done in wet forest. Need review of work done since 2000.
D3	Maintain habitat for flora and fauna	Species with specialised requirements (i.e. threatened species) have targeted management. Further monitoring required.
	Enhance opportunities for	Management (WHC) is effective for some species.

Code provision	Code 'interpreted-objectives' [a]	Effectiveness monitoring requirement [b]
	recolonisation of disturbed areas	Further work is required to examine other taxa and temporal changes.
	Maintain genetic resources	Management actions regarding the source of seed for reforestation in native forests needs to be monitored and compared with scientific literature on the maintenance of genetic diversity. Monitoring the effectiveness of contamination from plantations is required.
	Maintain connectivity	Species have been shown to use narrow patches of retained forest (e.g. SSR, WHS). The degree to which the retained areas connect habitat throughout the production forest landscape needs to be assessed.
	Maintain oldgrowth characteristics (including hollows)	A strategy for managing mature habitat is under development. A mapping layer has been produced to facilitate this management approach. The accuracy of the mapping layer needs to be tested. Monitoring effectiveness is required when a management approach is endorsed.
	Maintain species diversity	Research suggests species dependent on mature forest, especially those that are edge-affected, are most likely to be at risk. Recent work done in wet forest by Forestry Tasmania suggests most species are maintained. Further monitoring required.
D3.1	Protect areas from weeds and disease	Partly monitored through compliance assessments, and work done by Forestry Tasmania. Results suggest current management is effective but implementation is variable. Further monitoring required.
	Protect patches of myrtle and rainforest from fire	Monitoring required.
	Minimise disturbance to areas rich in epiphytic species	Monitoring required.
D3.2	Maintain habitat diversity	Monitored through the FPA Annual Report.
D3.3	Conserve threatened species	Some work has been done on particular species. Further monitoring required.
	Conserve inadequately reserved plant communities	Monitoring required.
E	Ensure reforestation	Monitored through compliance assessments. [c]
	Protect karst systems	Monitoring required.

[a] Note: The text contained in this table is the authors interpretation of the intent of management as indicated in the *Forest Practices Code*. These interpreted-objectives should not be interpreted directly as the objective of the code. Refer to the relevant section of the code for exact wording.

[b] Refer to Koch et al. (2012) for a summary of research and monitoring conducted.

[c] Compliance assessments are most likely to detect significant deviations from standard. The compliance assessment program is scheduled to be revised, and assessments will be aligned with scientific standards where possible.

The BLPG is an interpretation of the *Forest Practices Code* at the landscape scale. Consequently there is a large amount of overlap in the monitoring requirements of the code and the BLPG. An approach to monitoring the *Biodiversity landscape planning guideline* was outlined in Koch et al. (2011). Many of the projects outlined in this report were implementation monitoring projects. The goals and management targets of the BLPG are outlined in Table 6, with an indication of the requirement for effectiveness monitoring.

The information in Table 6 and Table 7, and in the review by Koch et al. (2012), was used to identify a number of monitoring projects required to assess the effectiveness of the forest practices system. Table 7 provides a summary of the relevant code provision and BLPG management target, the monitoring objectives, a brief description of a potential approach to monitoring, an assessment of the proportion of area covered by the forest practices system, or proportion of FPPs, that may be affected by this management issue, the expected effectiveness of that management, degree of uncertainty (high, medium or low) about whether the management is effective, and the effort to implement the proposed monitoring approach. This information (Table 7) was used to prioritise the code monitoring projects as outlined in Section 2 of this report, with Table 2 listing the projects by their relative ranking.

Table 6. The goals and management targets of the *Biodiversity landscape planning guideline,* indicating the requirement for effectiveness monitoring.

BLPG goals and management targets	Effectiveness monitoring requirement
1. Maintain an extensive and permanent native forest estate and avoid or minimise any permanent forest loss	Monitored in the FPA Annual report
1.1 A minimum of 95 per cent of the 1996 CRA native forest area is to be maintained on a statewide basis.	Implementation monitoring only
1.2 Maintain and/or enhance the area and/or condition of threatened native vegetation communities on public and private land.	Required
1.3 Ensure that conversion does not result in any non-threatened forest community becoming threatened.	Implementation monitoring only
1.4 Maintain priority forest communities on public land wherever prudent and feasible.	Implementation monitoring only
2. Maintain or improve landscape heterogeneity.	Required
2.1 Maintain the full range of seral stage patterns in native forest.	Required
2.2 Maintain remnant vegetation.	Implementation monitoring only
2.3 Ensure adequate regeneration in native forest harvest areas is achieved during each harvest cycle, including regeneration of the understorey.	Monitored during compliance assessments
3. Maintain connectivity of habitat for flora and fauna species.	Required
3.1 Maintain and/or enhance linkages along water courses and between water courses, capturing a range of habitat types and topographies.	Required
4. Maintain and/or improve the condition of freshwater ecosystems.	Required
4.1 Maintain water quality and flow within the range of natural variation over time.	Required

BLPG goals and management targets	**Effectiveness monitoring requirement**
4.2 Maintain and/or restore riparian vegetation and in stream habitat.	Required
5. Maintain and/or improve the condition of native habitats for flora and fauna, particularly priority species.	Required
5.1 Manage the risk of introducing disease into a 'healthy' habitat.	Required
5.2 Minimise the deleterious effects of weeds in native forests with particular focus on declared environmental weeds and native forest adjacent to plantations.	Required
5.3 Minimise harmful edge effects on reserves and sensitive vegetation communities and sensitive priority species habitat.	Required
5.4 Manage the risk of genetic pollution in threatened native eucalypt populations and areas of high conservation value as defined in FPA Technical note 12.	Required
5.5 Maintain soil fertility and structure.	Required
6. Maintain and/or improve the conservation status of forest species, their natural levels of genetic diversity.	Required
6.1 Maintain populations of RFA priority species throughout their ranges, through the management of potential habitat and other management actions.	Required

Table 7. Proposed objectives for projects to assess the effectiveness of the general biodiversity provisions delivered via the *Forest Practices Code* and *Biodiversity landscape planning guideline (BLPG),* indicating a proposed approach, and an assessment of the proportion of the area covered by the forest practices system or proportion of FPPs that may be affected, the expected effectiveness of management, the uncertainty about this effectiveness, and the effort to conduct the monitoring.

Code Provision	Code 'interpreted-objective' [a]	BLPG goal or management target	Research or monitoring objective	Proposed monitoring approach	Proportion affected	Management effectiveness	Uncertainty management is effective	Effort to monitor
D1	Prevent excessive nutrient loss	5.5	Determine whether soil productivity is maintained over the long-term by current forestry practices	Long-term monitoring sites and/or retrospective studies will be established in areas of high-intensity forestry, low intensity forestry, and intact forest to evaluate changes in productivity over time.	High	High	Low	Medium
D2	Maintain water quality	4.1	Determine whether water quality is maintained in streams under current management	Long-term monitoring sites will be established in streams in areas of high-intensity forestry, low intensity forestry, and intact forest to evaluate changes in water quality over time.	High	Medium	Low	Medium
D2	Maintain water flow	4.1	Determine the degree to which the coupe dispersal guidelines limit the amount of harvesting within a subcatchment and thereby reduce impact on water flow	A study will be done looking at the age of the forest at 5 m in height and comparing this to information available on changes in water use.	High	Medium	High	Medium
				GIS techniques will be used to examine the age structure of subcatchments subject to harvesting in Tasmania under the current coupe dispersal guidelines, and this will be related to available models and information on changes in water use with forest age.	High	Medium	High	Low

Code Provision	Code 'interpreted-objective' [a]	BLPG goal or management target	Research or monitoring objective	Proposed monitoring approach	Proportion affected	Management effectiveness	Uncertainty management is effective	Effort to monitor
D2	Maintain catchment and channel stability	4.1, 4.2	Determine whether current management maintains the geomorphology, sediment character and riparian vegetation structure of streams in the long-term	Monitor geomorphology, sediment character and riparian vegetation structure of headwater streams in areas previously (>5y) subject to harvesting under current machinery-exclusion guidelines, and in unharvested areas	High	High	Low	Medium
			In areas where streamside reserves are re-established, monitor whether this process was successful	Monitor regeneration and health of riparian vegetation which has been restored in second and subsequent rotation plantations and compare to control areas in native forest.	Low	Medium	Medium	Medium
D2	Maintain biodiversity in aquatic ecosystems	Goal 6 4.1, 4.2	Determine whether current SSR management maintains aquatic biodiversity over the long-term	Monitor fish and aquatic invertebrates in streams in areas previously (>5y) subject to harvesting under current management guidelines, and in unharvested areas.	High	High	Low	High
			Monitor whether aquatic contamination occurs from chemical application in plantations	Annually monitor a sample of catchments downstream of young plantations, with paired control sites that do not have plantations.	Medium	Medium	Medium	Medium

Code Provision	Code 'interpreted-objective' [a]	BLPG goal or management target	Research or monitoring objective	Proposed monitoring approach	Proportion affected	Management effectiveness	Uncertainty management is effective	Effort to monitor
D3.1, Flora Tech Note 6	Maintain habitat for flora and fauna	1.2, 2.2, 5.3	Determine whether current management recommendations are effective in maintaining the health of *Sphagnum* communities	*Sphagnum* communities adjacent to areas that have been harvested will be compared to similar communities adjacent to or within reserves. The health and cover of *Sphagnum* will be assessed at different distances from the edge and at different periods after harvesting. The impact of the edge environment and of harvesting will be examined over time.	Low	Medium	Medium	Medium
			Assess whether areas designated as offsets can maintain or develop the values that they are offsetting	Establish long-term monitoring plots in offsets as they are being established and assess size and health of the offsets.	Medium	Medium	High	Medium
			Monitor the health of retained remnants over time	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.	Medium	Low	Medium	Medium
			Determine whether buffers help maintain reserve health	Do a Vegetation Condition Assessment to assess the health of vegetation at distances from a harvested edge in areas of different forest types	Medium	Medium	Low	Medium
			See also Section 3 of this report					

Code Provision	Code 'interpreted-objective' [a]	BLPG goal or management target	Research or monitoring objective	Proposed monitoring approach	Proportion affected	Management effectiveness	Uncertainty management is effective	Effort to monitor
D3	Enhance opportunities for recolonisation of disturbed areas		Determine how remnant use by fauna changes over time	This study will continue the long-term monitoring of wildlife habitat clumps, paddock trees and small remnants retained in plantation areas, and in adjacent farming land.	Medium	High	Medium	High
			Determine whether WHC help maintain forest birds, fungi and bryophytes in forestry areas	Surveys of birds, bryophytes and fungi would be conducted in WHC retained in forestry areas, as well as adjacent areas of intact forest. The species composition of the retained and intact patches would be compared.	High	Medium	Medium	Medium
D3	Maintain genetic resources	5.4	Determine whether buffers for protecting areas of intact forest are effective at minimising the hybridisation of exotic species	A study will examine the occurrence of hybridisation in areas with and without such buffers.	Low	Medium	Low	Medium
D3.2	Maintain connectivity	Goal 3	Determine the degree of connectivity across the state	GIS techniques will be used to determine where formal and informal reserves (including WHS and SSR) are located across the state, the degree to which forested areas are isolated, and to which areas of old forest are isolated.	High	High	Medium	Medium

Code Provision	Code 'interpreted-objective' [a]	BLPG goal or management target	Research or monitoring objective	Proposed monitoring approach	Proportion affected	Management effectiveness	Uncertainty management is effective	Effort to monitor
D3	Maintain oldgrowth characteristics (including hollows)	2.1	Determine whether the Mature Habitat Availability Map can be used to assess the availability of mature forest features (e.g. hollows and coarse woody debris)	Survey strip transects for hollows and coarse woody debris in areas mapped as high, medium, low and negligible mature habitat availability.	High	Medium	Medium	Medium
			Determine the degree to which mature habitat availability is changing across the forest estate in Tasmania	If the Mature Habitat Availability Map is found to be a reflection of mature habitat features, monitor changes in the Map and Mature Habitat over time to determine whether mature features are maintained under current management.	High	Medium	High	Low
D3	Maintain species diversity	Goal 6	Determine whether species diversity is maintained in areas subject to forestry activities	Conduct biodiversity surveys in landscapes subject to forestry and comparable areas in reserve, and conduct species trend monitoring	High	Medium	Medium	High
D3.1, E4	Protect areas from weeds and disease	5.1, 5.2, 5.3	Determine the extent of myrtle wilt in areas subject to harvesting	Data on the occurrence of myrtle wilt will be collected at a range of sites subject to harvesting. The rates of myrtle wilt will be compared to the data collated by Elliott et al. (2005) before the hygiene measures were applied.	Low	Low	High	Medium
			Determine if the hygiene measures help prevent the spread of *Phytophthora cinnamomi*	Stations for monitoring *Phytophthora* in new roads will be established for long-term monitoring.	High	Medium	High	Medium

Code Provision	Code 'interpreted-objective' [a]	BLPG goal or management target	Research or monitoring objective	Proposed monitoring approach	Proportion affected	Management effectiveness	Uncertainty management is effective	Effort to monitor
			Determine whether buffers for protecting areas of intact forest are effective at minimising the spread of weeds	A study will examine the occurrence of weeds in areas with and without such buffers.	Medium	Medium	Low	Medium
D3.1	Protect patches of myrtle and rainforest from fire	5.3	Determine whether current management recommendations are effective in maintaining the health of relict rainforest	Vegetation Condition Assessments will be done to assess the health of patches of relict rainforest at different distances from the edge of the forest and at different periods after harvesting. The results will be compared to similar data collected from larger patches of intact rainforest.	Low	High	Low	Medium
D3.1	Minimise disturbance to areas rich in epiphytic species	5.3	Determine whether epiphytic species richness is maintained in retained areas	Monitor epiphytic species richness in areas retained during harvesting and comparable areas not subject to harvesting. Monitor over time.	Medium	Medium	Medium	High
D3.3	Conserve threatened species	Goal 6	Determine if threatened flora are maintained in wildlife habitat clumps	The abundance, age structure and health of threatened plants in WHC (applied to manage these threatened plants) would be compared to patches of similar intact habitat and monitored over time.	Medium	High	Medium	Medium
			Determine whether significant habitat definitions for threatened species are adequate	Collaborate with experts to review habitat definitions and establish spatial layers that can be used to reflect habitat suitability.	High	High	High	Medium
			See also Section 3 of this report					

Code Provision	Code 'interpreted-objective' [a]	BLPG goal or management target	Research or monitoring objective	Proposed monitoring approach	Proportion affected	Management effectiveness	Uncertainty management is effective	Effort to monitor
D3.3	Conserve inadequately reserved plant communities	Goal 6	Determine whether threatened vegetation communities recover after harvesting	Vegetation composition and structure would be examined in harvested and unharvested areas of threatened vegetation communities over time. The change in species composition, level of regeneration and the occurrence of weeds over time would be compared between the harvested and unharvested sites.	Low	High	Medium	Medium
D6	Protect karst systems	4.1, 6.1	Determine whether current management guidelines of karst systems maintain abiotic conditions	The abiotic conditions in two karst system will be monitored over time, one system in a subcatchment subject to harvesting and the other in an adjacent subcatchment without harvesting.	Low	Medium	High	Medium

Appendix 2: Management objectives for threatened fauna in Tasmania

One of the desirable features of an effectiveness monitoring program is that it aligns with management objectives, targets and reporting requirements (Koch et al. 2011). Some management objectives are provided in documents such as recovery plans and strategic species plans. However, these broad objectives generally relate to species recovery, which can require actions beyond the capacity of the Tasmanian forest practices system. Therefore the objectives provided in recovery plans cannot generally be directly translated into management objectives for the forest practices system.

The Threatened Fauna Adviser (TFA) is a management tool that delivers recommendations on threatened species management to forest planners in Tasmania. The context of the forest practices system was considered during the development of the objectives delivered via the TFA, and so these objectives are used for the current project (Table 8). However, it should be noted that the TFA objectives tend to be broad and generic and so provide only limited guidance for monitoring programs.

Table 8. Management objectives for fauna species in Tasmania as identified in the Threatened Fauna Adviser

SPECIES	MANAGEMENT OBJECTIVE
MAMMALS	
Spotted-tailed quoll (*Dasyurus maculatus* subsp. *maculatus*)	To implement actions that will assist the maintenance of populations throughout the range of the species, primarily through the maintenance of potential habitat.
Eastern barred bandicoot (*Perameles gunnii* subsp. *gunnii*)	To implement actions that will assist the maintenance of populations throughout the range of the species, primarily through the maintenance of potential habitat.
New Holland mouse (*Pseudomys novaehollandiae*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
Tasmanian devil (*Sarcophilus harrisii*)	To implement actions that will assist the maintenance of populations throughout the range of the species, primarily through the maintenance of potential maternal denning habitat. as well as cover for hunting and resting, to support a prey base and to reduce conflict with introduced predators and humans.
Flinders Island wombat (*Vombatus ursinus* subsp. *ursinus*)	To implement actions that will assist the maintenance of populations of throughout its range, primarily through the maintenance of potential habitat.
BIRDS	
King Island birds (KI green rosella, KI brown thornbill, KI scrubtit)	To implement actions that will assist the maintenance of populations of throughout their ranges, primarily through the protection of potential habitat.
Grey goshawk (*Accipiter novaehollandiae*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat, particularly habitat known to be of high priority for breeding.
Wedge-tailed eagle (*Aquila audax* subsp. *fleayi*)	To implement actions that will assist the maintenance of breeding pairs of the wedge-tailed eagle throughout its range, primarily through the maintenance of nesting habitat known to be of high priority for breeding. Potential nesting habitat must be maintained to help meet this objective.
White-bellied sea-eagle	To implement actions that will assist the maintenance of breeding pairs of

SPECIES	MANAGEMENT OBJECTIVE
(*Haliaeetus leucogaster*)	the wedge-tailed eagle throughout its range, primarily through the maintenance of nesting habitat known to be of high priority for breeding. Potential nesting habitat must be maintained to help meet this objective.
Tasmanian azure kingfisher (*Ceyx azureus* subsp. *diemenensis*)	To implement actions that will assist the maintenance of populations throughout its core range, primarily through the maintenance of potential habitat and breeding sites.
Swift parrot (*Lathamus discolor*)	The overall objective of the Planning Guideline (FPA 2010) is to maintain the integrity of breeding-habitat by ensuring that sufficient levels and arrangement of nesting-habitat and foraging-habitat are retained to support a breeding event in any given year and, in this way, contribute to the objectives of the Draft national recovery plan for the swift parrot *Lathamus discolor* (Swift Parrot Recovery Team 2010).
Orange-bellied parrot (*Neophema chrysogaster*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
Forty-spotted pardalote (*Pardalotus quadragintus*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known colonies and maintenance of potential habitat.
Tasmanian masked owl (*Tyto novaehollandiae* subsp. *castanops*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of known nest sites and potential habitat.
AMPHIBIANS	
Green and gold frog (*Litoria raniformis*)	To implement actions that will assist the maintenance of populations throughout their range, primarily through the maintenance of potential habitat. Known sites and associated habitat must be protected to help meet this objective.
Striped marsh frog (*Limnodynastes peroni*)	To implement actions that will assist the maintenance of populations throughout their range, primarily through the maintenance of potential habitat. Known sites and associated habitat must be protected to help meet this objective.
REPTILES	
Tussock skink (*Pseudemoia pagenstecheri*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Glossy grass skink (*Pseudemoia rawlinsoni*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
FRESHWATER FISH	
Australian grayling (*Prototroctes maraena*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Swan galaxias (*Galaxias fontanus*) and dwarf galaxiid (*Galaxiella pusilla*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.
Swamp galaxias (*Galaxias parvus*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.
Clarence galaxias (*Galaxias johnstoni*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.

SPECIES	MANAGEMENT OBJECTIVE
Saddled galaxias (*Galaxias tanycephalus*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.
Arthurs paraglaxias (*Paragalaxias mesotes*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.
Golden galaxias (*Galaxias auratus*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.
Great Lake paragalaxias (*Paragalaxias eleotroides*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.
Shannon paraglaxias (*Paragalaxias dissimilis*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.
INVERTEBRATES	
Tasmanian chaostola skipper (*Antipodia chaostola* subsp. *leucophaea*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known colonies and the maintenance of potential habitat.
Marrawah skipper (*Oreisplanus munionga* subsp. *larana*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known colonies and the maintenance of potential habitat.
Ptunarra brown butterfly (*Oreixenica ptunarra*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known colonies and the maintenance of potential habitat.
Tasmanian hairstreak butterfly (*Pseudalmenus chlorinda* subsp. *myrsilus*)	To implement actions that will assist the maintenance of populations throughout their range, primarily through the protection of known colonies and the maintenance of potential habitat.
Tunbridge looper moth (*Chrysolarentia desicaria*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the protection of known colonies and the maintenance of potential habitat.
Chevron looper moth (*Amelora acontistica*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the protection of known colonies and the maintenance of potential habitat.
Saltmarsh looper moth (*Dasybela achroa*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the protection of known colonies and the maintenance of potential habitat.
Chequered blue butterfly (*Theclinesthes serpentata* subsp. *lavara*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the protection of known colonies and the maintenance of potential habitat.
Giant freshwater crayfish (*Astacopsis gouldi*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Furneaux burrowing crayfish (*Engaeus martigener*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the protection of known sites and the maintenance of potential habitat.
Central north burrowing crayfish (*Engaeus granulatus*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the protection of known sites and the maintenance of potential habitat.
Scottsdale burrowing crayfish (*Engaeus spinicaudatus*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the protection of known sites

SPECIES	MANAGEMENT OBJECTIVE
	and the maintenance of potential habitat.
Burnie burrowing crayfish (*Engaeus yabbimunna*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the protection of known sites and the maintenance of potential habitat.
Mt Arthur burrowing crayfish (*Engaeus orramakunna*)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the protection of known sites and the maintenance of potential habitat.
Southern hairy red snail (*Austrochloritis victoriae*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
Skemps snail (*Charopidae* 'Skemps')	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
Ammonite snail (*Discocharopa vigens*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
Burgundy snail (*Helicarion rubicundus*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Cataract gorge snail (*Pasmaditta jungermanniae*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Keeled snail (*Tasmaphena lamproides*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Invertebrates – Freshwater snails	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat and protection of known localities.
Invertebrates – Caddisflies	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.
Invertebrates – Great Lake species	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.
Miena Jewel beetle (*Castiarina insculpta*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Green-lined ground beetle (*Catadromus lacordairei*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
Weldborough forest weevil (*Enchymus* sp. nov.)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Bornemisszas stag beetle (*Hoplogonus bornemisszai*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Vanderschoors stag beetle (*Hoplogonus vanderschoori*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Simsons stag beetle (*Hoplogonus simsoni*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential

SPECIES	MANAGEMENT OBJECTIVE
	habitat.
Broad-toothed stag beetle (*Lissotes latidens*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Mt Mangana stag beetle (*Lissotes menalcas*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Cave fauna (not including southern sandstone cave cricket)	To implement actions that will assist the maintenance of populations throughout their ranges, primarily through the maintenance of potential habitat.
Southern sandstone cave cricket (*Micropathus kiernani*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the maintenance of potential habitat.
Plomleys trapdoor spider (*Migas plomleyi*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
Lake Fenton trapdoor spider (*Plesiothele fentoni*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
Blind velvet worm (*Tasmanipatus anophthalmus*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
Giant velvet worm (*Tasmanipatus barretti*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.
Salt Lake slater (*Haloniscus searlei*)	To implement actions that will assist the maintenance of populations throughout its range, primarily through the protection of known sites and the maintenance of potential habitat.

Appendix 3: Assessing the threats to and management of threatened fauna in Tasmania

The effectiveness monitoring projects were prioritised by identifying all known threats to species (that are relevant to the forest industry), linking each threat to one or more of the management actions delivered via the TFA (FPA & TSS 2012), and assessing each threat-management pair for a number of attributes. Initial assessments were made by FPA staff, and feedback was then sought from specialists. The following personnel were asked to provide feedback on the assessments made for the indicated species (names in italics indicate a response has yet to be received):

- *Phil Bell, Clare Hawkins, Karen Richards* (TSS): All species
- *Marie Y*ee (FT): Stag beetles, and industry impacts for all species
- Kevin Bonham (private): Terrestrial snails, velvet worms
- *Rob Freeman* (IFS): Fish species, burrowing crayfish and Great Lake invertebrates
- Bill Brown (DPIPWE): Wedge-tailed eagle, white-bellied sea eagle, grey goshawk, masked owl
- *Annie Phillips* (DPIPWE): Frogs
- *Billie Lazenby* (DPIPWE): New Holland mouse
- Ray Brereton (Entura): Skinks
- *Niall Doran* (UTAS): Crayfish and salt lake slater
- *Jean Jackson* (private): Fish and caddisflies
- *Peter Davies* (private)
- *Mark Wapstra* (private)
- *Menna Jones* (UTas).

The results of the assessments are provided in Table 9.

Table 9. Assessments of the threats and management actions for threatened fauna species in Tasmania. Columns are defined according to Table 3. MI = management importance; TI = threat importance; ME = management effectiveness; UME = uncertainty management is effective; EM = effort to monitor; AMM = ability to modify management; II = impact on industry; CIAT = capacity for industry to alleviate threat; Metric = metric of importance.

Species	Threat	Management	MI	TI	ME	UME	EM	AMM	II	CIAT	Metric
Australian grayling	Loss of streamflow	No adjacent harvesting	High	High	Med	Med	Med	Med	Med	Low	High
		Restore riparian veg in plantations	Med	High	Low	Low	Med	Med	High	Low	High
		SSR (wider)	Med	High	Low	Low	High	Med	Low	Low	High
	Decline in water quality	SSR (wider)	High	Med	Med	Low	Med	Med	Med	Med	Med
		Restore riparian veg in plantations	Med	Med	Low	Low	Med	Med	High	High	High
		Cultivation methods in plantations	Med	Med	Med	Med	High	Low	High	Low	Med
	Fragmentation of populations	Build culverts	High	Med	Med	Low	Med	Low	High	Med	Med
Azure kingfisher	Loss of breeding sites	Apply SSR on class 1 streams	High	High	High	Low	High	Med	High	Med	Med
Burgundy snail	Loss of habitat (wet forest)	SSR – widen Class 4	High	High	Med	Med	Med	Med	Med	High	High
		Retain 20% habitat in CBS	High	High	Med	Low	Med	Med	High	High	High
		No conversion of significant habitat	Med	High	Med	Med	Med	Low	Low	High	High
		WHS	Med	High	Med	Med	Low	Med	Med	High	
		WHC	Low	High	Low	Low	Med	High	Med	High	High
		No roads within 30m of significant habitat	Low	High	Low	Low	Med	Med	High	Med	High
	Loss of potential habitat (wet forest all ages)	Restoration of SSR in plantation	Med	High	Low	High	Med	Med	Med	High	High
	Fragmentation of habitat	Coupe dispersal (also 50% boundary >25yo forest)	High	Med	Med	Med	Med	Med	Med	High	Med
		WHS	Med	Med	Med	Med	Med	Med	Med	High	Med
Burrowing crayfish	Change in stream flow	Increase SSR width by 10m	High	High	High	Med	Med	Med	Med	High	Med
	Loss of habitat (all native vegetation in area)	No conversion of significant habitat	High	High	High	Med	High	Low	High	High	Med

Species	Threat	Management	MI	TI	ME	UME	EM	AMM	II	CIAT	Metric
	Decline in water quality	Increase SSR width by 10m	High	Med	High	Med	Med	Med	Med	High	Low
		Maintain or restore riparian vegetation in plantations	Med	Med	Med	Med	High	Med	Med	Med	Med
		Build culverts	Low	Med	Med	Low	Med	Low	High	Med	Med
		Roads 100 m from known sites	Low	Med	High	Low	Med	High	Low	Low	Low
	Loss of food availability	Increase SSR width by 10m	High	Low	High	Med	Med	Med	Med	High	Low
Caddis flies	Habitat loss and degradation (riparian and waterbodies)	Increase class 4 reserve to 10m	High	High	High	Med	High	Med	High	Med	Med
		No conversion of class 4 streams	Med	High	Med	Low	High	Med	High	Med	High
		If known site, 30m SSR	Low	Med	High	Med	High	Med	High	Med	Low
Cave fauna	Loss or degradation of potential habitat (especially hydrology of caves)	Disperse coupes (not adjacent)	High	High	Med	Med	High	Med	High	Med	High
		No chemical in feeder streams	Med	High	Med	Med	Med	Med	High	High	High
		Upgrade class 3 and 4 SSR	Med	High	Low	Med	High	Med	High	Med	High
		Revegetation SSR in plantations	Med	High	Med	Med	High	Med	High	Med	High
Chaostola & marrawah skippers, hairstreak butterfly	Habitat loss (land clearance)	WHC in patchy habitat	Med	High	Low	Med	Med	Med	Med	High	High
		>30m between road and habitat	Low	High	Med	Med	Med	Med	Med	Med	High
Eastern barred bandicoot	Road kill	Distance between road and significant habitat	High	Med	Med	Med	Med	Med	Med	Low	Med
	Loss of ground cover for shelter and den sites (grasses, shrubs, CWD)	Maintain CWD	High	Low	High	High	High	Low	Low	High	Low
		Maintain intact native vegetation (WHC)	Med	Low	Low	Low	High	Med	Med	Med	Med
		Minimise loss of CWD in regeneration burns	Med	Low	High	High	Med	Low	Low	Med	Low
		Restore quarries	Low	Low	Low	Low	Med	Low	Med	Med	Med
	Population isolation	Maintain strips in plantations	High	Low	Low	Med	Low	Med	Med	High	Med

Species	Threat	Management	MI	TI	ME	UME	EM	AMM	II	CIAT	Metric
Flinders island wombat	Loss of native vegetation	No conversion	High	Med	High	Low	High	Med	Low	High	Low
Forty-spotted pardalote	Insufficient *E. viminalis* forest	No harvesting of *E. viminalis*-dominated forest	High	High	High	Low	High	Low	Med	Med	Med
		No conversion	Med	High	Med	Low	Low	Low	Med	Med	High
	Lack of nesting hollows	Apply twice rate of WHC	High	Med	Low	Low	High	High	Med	Med	High
Frogs	Loss of shelter sites	30 m buffer	High	High	High	Med	Med	High	Low	Low	Med
		SSR (10m for class4)	Med	High	Med	Med	High	Med	Med	High	High
	Chytrid fungus	Use hygiene measures	High	Med	Med	High	Med	Med	Low	Low	Med
	Desiccation of waterbodies	30 m buffer	High	Med	Low	Med	High	High	Low	Low	High
		SSR (10m for class4)	Med	Med	Med	Med	Med	Med	Med	Med	Med
Giant freshwater crayfish	Change in stream morphology and water quality	Increase SSR on high value streams	High	High	Med	Med	Med	Med	Med	High	High
		Maintain or restore riparian vegetation in plantations	Med	High	Med	Med	High	Med	Med	Med	High
		Build culverts	Low	High	Med	Low	Med	Low	High	Med	High
	Change in flow regime	Coupe dispersal	High	Low	Low	Med	High	Med	High	High	Med
Glossy grass skink	Loss of habitat (wetlands and swampy sites)	20m on non-stream waterbodies	High	High	Med	Med	Med	Med	Med	Low	High
		20m SSR on class 4	Med	Med	Med	Med	Med	Med	Med	Low	Med
Great lake & shannon galaxiid	Loss of habitat	40m SSR on lake	High	Med	High	High	High	Med	Low	Low	Low
		Increase SSR width	Med	Med	High	High	High	Med	Low	Low	Low
	Fragmentation of population	Build bridges/culverts	High	Low	Low	Med	Med	Med	High	Med	Med
	Loss of water quality	40m SSR	High	Low	High	Low	Med	Med	Low	Low	Low
		Maintain and restore remnant riparian veg in wider SSR	Med	Low	Med	Med	High	Med	Med	Med	Low
		Roads >100m from water bodies	Low	Low	High	Low	Med	High	Low	Low	Low

Species	Threat	Management	MI	TI	ME	UME	EM	AMM	II	CIAT	Metric
Great lake invertebrates	Loss of water quantity	40m SSR	High	Low	High	Low	Med	Med	Low	Low	Low
		Maintain and restore remnant riparian veg in wider SSR	Med	Low	Med	Med	High	Med	Med	Med	Low
Grey goshawk	Loss of foraging habitat (swamp forest)	No conversion	High	High	Med	Med	Med	Med	Med	High	High
	Loss of mature forest structure	Retain 20% mature forest in 1–5k radius	High	High	Med	Med	High	Med	Med	High	High
		Apply wide SSR	High	High	High	Med	Med	Med	Med	High	Med
		No conversion	Med	High	Med	Med	Med	Med	Med	High	High
	Loss of nest sites	Area retained around known nests	High	High	High	Low	Low	Low	Low	High	Med
Hydrobiid snails	Loss of water quality	Increase SSR (bigger if known site)	High	High	High	Med	High	Med	High	Med	Med
		No conversion of riparian veg on class 4 streams	Med	High	Med	Low	High	Med	High	Med	High
Keeled snail	Loss of potential habitat (wet forest >30yo)	In Woolnorth (Jims plains area) do WHS	High	High	Med	Med	Med	Med	High	High	High
		No conversion of significant habitat	High	High	Med	Low	Low	Low	Med	High	High
		In Woolnorth do WHC	Low	High	Low	Low	Med	Med	Low	High	High
King Island birds	Habitat loss (forest cover)	No conversion	High	High	Med	Low	High	Low	Med	Med	High
	Habitat loss (mature forest with hollows)	Retain mature forest (WHC)	High	High	Low	Low	Med	Med	Med	Med	High
Masked owl	Lack of nest hollows	Retain 30% of landscape as mature habitat	High	High	Med	Med	High	Low	High	High	High
		No conversion of mature forest	Med	High	Med	Low	High	Med	High	High	High
		Retain suitable paddock trees	Med	High	Low	Low	High	Med	Med	High	High
	Loss of known nest sites	Retain area around nest	High	High	High	Low	Med	Med	Med	Med	Med
New Holland mouse	Habitat loss (vegetation species)	Apply appropriate burn regime	High	Med	NA	NA	High	Low	Low	High	NA
		No conversion of habitat	High	Low	High	Low	High	Low	Low	High	Low

Species	Threat	Management	MI	TI	ME	UME	EM	AMM	II	CIAT	Metric
		No roads nest to significant habitat	Low	Low	Low	Med	Med	Med	Med	High	Med
		Retain intact vegetation (WHCs)	Low	Low	Low	Low	Med	Med	Med	High	Med
		Washdown to prevent disease spread	Low	Low	Low	High	High	Low	Med	High	Med
Ptunarra butterfly	Habitat loss (*Poa* dominated areas >20%) (i.e. landclearance)	No conversion of significant habitat	High	High	High	Low	Low	Low	Low	Med	Med
		Avoid harvesting potential habitat	Med	High	Med	Low	High	Med	Med	Med	High
		Only low intensity burns	Med	High	High	Low	Med	Low	Med	Med	Med
		>30m between road and habitat	Low	High	Med	Med	Med	Med	Med	Med	High
	Individual mortality	10 m buffer around known colony	High	High	High	Med	High	Med	Med	Med	Med
Skemps snail	Loss of habitat (wet forest)	Retain 20% habitat in CBS	High	High	Med	Low	Med	Med	High	High	High
		SSR – widen Class 4	High	High	Med	Med	Med	Med	Med	High	High
		No conversion of significant habitat	Med	High	Med	Med	Med	Low	Low	High	High
		WHS	Med	High	Med	Med	Low	Med	Med	High	
		WHC	Low	High	Low	Low	Med	High	Med	High	High
		No roads within 30m of significant habitat	Low	High	Low	Low	Med	Med	High	Med	High
	Fragmentation of habitat	Coupe dispersal (also 50% boundary >25yo forest)	High	Med	Med	Med	Med	Med	Med	High	Med
		WHS	Med	Med	Med	Med	Med	Med	Med	High	Med
Spotted tail quoll	Isolation of individuals or populations	Maintain existing forest cover including remnants (no conversion)	High	Med	Med	Med	High	Med	Med	High	Med
	Destruction of inhabited maternal dens	Avoid burning windrows in breeding season	High	Low	Low	High	High	Med	Low	Med	Med
	Insufficient denning habitat	Maintain mature forest	High	Low	Med	Med	High	Med	Med	High	Low
	Loss of existing dens	Identify and protect known dens	High	Low	Low	High	High	Med	Med	Med	Med
Stag Beetle:	Habitat loss (CWD and soil)	Increase class 4 SSR to 10 m	Med	Med	Med	Med	Med	Med	Low	Med	Med

Species	Threat	Management	MI	TI	ME	UME	EM	AMM	II	CIAT	Metric
Broad toothed		No conversion of wet forest in known range	Med	Med	Med	Med	Med	Low	Med	Med	Med
		Coupe dispersal (50% boundary *Eucalypt* forest >30yo)	Med	Med	High	Med	Med	Med	Med	Med	Low
		WHC in mature habitat	Low	Med	Low	Low	Med	High	Med	Med	High
		Roads >30m from potential habitat	Low	Med	Low	Low	Med	Med	Med	Med	High
		Avoid burning potential habitat	Low	Med	Med	Med	Med	Low	Med	Med	Med
	Habitat loss (CWD)	No firewood harvesting	Low	Med	Low	Med	Med	Low	Low	Med	High
		Retain remnants in plantations	Low	Med	Med	Med	Med	Med	High	Med	Med
		If lots of riparian veg then restore	Low	Med	Med	Med	Med	Med	Med	Med	Med
Stag beetle: Mt Mangana	Habitat loss (CWD)	Mature habitat approach	High	High	High	Med	Med	Med	High	High	Med
		No conversion of mature forest in known range	Med	Med	Med	Med	Med	Low	Med	Med	Med
		Roads >30m from potential habitat	Low	Med	Low	Low	Med	Med	Med	Med	High
		WHC	Low	Med	Med	Med	Med	High	Med	Med	Med
Stag Beetles: Bornemisszas, Vanderschoors & Simpsons	Habitat loss (CWD and soil)	No forestry in SMZ	High	Med	High	Low	Med	Low	Low	Med	Low
		Increase class 4 SSR to 10 m	Med	Med	Med	Med	Med	Med	Low	Med	Med
		No conversion of wet forest in known range	Med	Med	Med	Med	Med	Low	Med	Med	Med
		Coupe dispersal (50% boundary euc forest >30yo)	Med	Med	High	Med	Med	Med	Med	Med	Low
		WHC in mature habitat	Low	Med	Low	Low	Med	High	Med	Med	High
		Roads >30m from potential habitat	Low	Med	Low	Low	Med	Med	Med	Med	High
		Avoid burning potential habitat	Low	Med	Med	Med	Med	Low	Med	Med	Med
Swift parrot	Insufficient foraging resource to maintain population during the	In core range outside SPIBA retain high density foraging and 50% foraging trees in medium/low	High	High	Med	Med	High	Med	High	High	High

Species	Threat	Management	MI	TI	ME	UME	EM	AMM	II	CIAT	Metric
	breeding season	In SPIBA retain all high/medium foraging and 50% of foraging in low	High	High	Med	Med	High	Med	High	High	High
		No conversion of potential habitat	Med	High	Med	Low	Low	Low	Med	High	High
	Insufficient tree hollows to maintain breeding population	In SPIBAs retain all high and medium density nesting habitat (+90% of nest trees if <30% maturity in SPIBA)	High	High	Med	Med	High	Low	High	High	High
		In core range outside SPIBA retain high and medium density nesting habitat (if <30% mature)	High	High	Med	Med	High	Low	High	High	High
		Reserve around known nests	Med	High	Low	Med	Low	Med	Med	High	High
		No conversion of potential habitat	Med	High	Med	Low	Low	Low	Med	High	High
Tasmanian devil	Loss of known dens	No disturbance within distance of known den	High	Med	High	Low	Med	Med	Med	Med	Low
	Breeding failure due to disturbance	No burning windrows in breeding season	High	Low	Low	High	High	Low	Low	Med	Med
		No noisy activities within distance of den in diseased area	Med	Low	Med	High	High	Med	Med	Med	Low
	Loss of important habitat (latrine sites)	No roads on latrine sites	High	Low	Low	High	High	Med	Med	High	Med
	Loss of potential denning habitat	Retain intact vegetation (WHCs)	High	Low	Low	Low	Med	Med	Med	High	Med
Tussock skink	Loss of habitat (grassland and grassy woodland)	WHC	High	High	Low	Low	Med	High	Med	Low	High
Velvet worm: blind	Habitat loss and degradation (CWD)	No firewood harvesting	Low	High	Low	Med	Med	Low	Low	Med	High
Velvet worm: blind & giant	Habitat loss and degradation (CWD)	No high intensity burns	High	High	Med	Med	Med	Low	High	Med	High
		WHS	Med	High	Med	Med	Low	Med	Med	Med	High

Species	Threat	Management	MI	TI	ME	UME	EM	AMM	II	CIAT	Metric
		Class 4 SSR increased to 10m	Med	High	Low	Med	Med	Med	Med	Med	High
		No conversion of significant habitat	Med	High	High	Med	Med	Low	Med	Med	Med
		Roads >100m from site	Low	High	Med	Med	Med	Med	High	High	High
		Roads >30m from potential habitat	Low	High	Low	Low	Med	High	Med	Med	High
		WHC (double for GVW)	Low	High	Low	Low	Med	High	Med	Med	High
Velvet worm: giant	Habitat loss and degradation (CWD)	Coupe dispersal	Med	High	Med	Med	Med	Med	High	Med	High
Wedge-tailed eagle (and WBSE)	Breeding failure due to disturbance	No activity within 1 km line-of-sight during breeding season	High	High	Med	High	High	Med	High	High	High
		Reserve around nests	High	High	Med	Low	High	Med	High	High	High
		No conversion within 1 km line-of-sight	Med	High	Med	Med	High	Med	High	High	High
	Lack of nest sites	Retain reserve around nests	High	High	High	Low	Med	Med	High	High	Med

Appendix 4. Management planning required for the TFA

During the review of the TFA it was apparent that there are no established management strategies for a number of threats to RFA priority species. The species, and associated threats that require management, are ranked in Table 10 according to a combination of threat importance and capacity of industry to alleviate threat.

Table 10. The priorities for management planning, as ranked according to threat importance and capacity of the forest industry to alleviate the threat

ID	Species	Threat	Threat importance	Capacity of industry to alleviate threat
1	Southern hairy red snail	Habitat clearance through land clearance (loss of litter)	High	High
2	New Holland Mouse	Fragmentation of populations	High	High
3	Chaostola & marrawah skipper,s hairstreak butterfly	Habitat loss (land clearance)	High	High
4	Ammonite snail	Loss of habitat (eucalypt forest on dolerite)	High	High
5	Green lined beetle	Habitat loss and degradation (grassland and wetland etc)	High	High
6	Weldborough forest weevil	Habitat loss (mature native forest)	High	High
7	Chaostola & marrawah skipper,s hairstreak butterfly	Habitat loss (land clearance)	High	High
8	Trapdoor spiders	Habitat loss (moss boulders, CGTS, wet forest and subalpine forest LFTS)	High	Medium
9	Frogs	Fragmentation of populations	Medium	Medium
10	Stream galaxiids (swan & dwarf)	Change to water level (stream flow)	Medium	Medium
11	Schayers grasshopper	Habitat loss and degradation (uncertain)	Medium	Medium
12	Hydrobiid snails	Change in water flow regime	Medium	Medium
13	Caddis flies	Alteration to drainage	Medium	Medium
14	Saltmarsh moths & butterflies	Loss of habitat	High	Low
15	Saltmarsh moths & butterflies	Habitat degradation	High	Low
16	Southern hairy red snail	Fire (loss of litter)	High	Low
17	Cataract Gorge snail	Loss of potential habitat (native vegetation with rocks)	High	Low
18	Clarence & swamp galaxiid	Loss of habitat due to inundation	High	Low
19	Clarence & swamp galaxiid	Competition/predation from trout and introduced fish	High	Low
20	Lake galaxiids (golden, arthurs, saddled)	Predation	High	Low
21	Lake galaxiids (golden, arthurs, saddled)	Loss of habitat	High	Low

ID	Species	Threat	Threat importance	Capacity of industry to alleviate threat
22	Stream galaxiids (swan & dwarf)	Predation	High	Low
23	Salt lake slater	Habitat degradation (salt lakes/lagoons)	High	Low
24	Forty-spotted pardalote	Fragmentation of population	Medium	Low
25	Miena Jewel beetle	Habitat loss (open forest, shrubby veg)	Medium	Low
26	Ptunarra butterfly	Predation by wasps	Medium	Low
27	Chaostola & marrawah skipper,s hairstreak butterfly	Habitat degradation (lack of fire)	Medium	Low
28	Lake galaxiids (golden, arthurs, saddled)	Loss of water quality	Medium	Low
29	Great lake & shannon galaxiid	Competition with introduced species	Medium	Low
30	Ammonite snail	Competition/predation from invasives	Medium	Low
31	Australian grayling	Decline in water quality	Medium	Low
32	Miena jewel beetle	Illegal collection	Low	Low

Appendix 5. Process for the development, review and continual improvement of the provisions of the *Forest Practices Code*

The forest practices system's adaptive management process, in relation to many biodiversity values, can be summarised as follows:

- The most up-to-date information is gathered from published and non-published sources to determine the 'expert opinion' with respect to the value in question and its likely response to various forms of forest management.
- The information gathered is used to develop management actions for the value. This may be done through a technical working group (e.g. fauna/flora strategic planning groups, hollows working group) convened for the particular value or issue.
- Comment is sought from all stakeholders, particularly practitioners (FPOs), on the proposed management actions and any associated implementation tools (e.g. policies, DSS, technical notes, etc.).
- Public comment will be sought where the management actions are deemed to be changes to the *Forest Practices Code* or changes to endorsed management prescriptions under the Regional Forest Agreement.
- The final decision on adoption or amendment of the management actions and any associated implementation tools is made by the Board of the Forest Practices Authority (and Secretary of DPIPWE in the case of actions relating to threatened species) who may seek advice from the Forest Practices Advisory Council, Threatened Species Scientific Advisory Committee and any other advisory bodies as required and in accordance with the Agreed Procedures under the *Forest Practices Code*.
- Training, education and awareness programs are conducted on a regular basis for forest practices officers, other planning and supervisory staff employed throughout the forest industry and landowners.
- The management actions are incorporated into forest practices plans through approved planning tools and procedures.
- The implementation of forest practices plans is monitored by Forest Practices Officers and FPA Compliance Officers.
- Research is conducted to improve understanding of the value in question and its response to different impacts.
- Monitoring is carried out by specialists to assess the efficacy of management actions.

The management actions are reviewed and revised on a regular basis to incorporate the findings of new research, results from monitoring and operational experience.