Monitoring the effectiveness of the biodiversity provisions of the Tasmanian *Forest Practices Code*

2014–15 summary report

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Report for the Board of the Forest Practices Authority and the Secretary of the Department of Primary Industries, Parks, Water and Environment

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Disclaimers

The information presented is a broad overview of information considered relevant (by the authors) to the aim of this report. Whilst the authors have used best endeavours to ensure accuracy, they do not warrant that the material is free of error. Consequently, the information is provided on the basis that the authors will not be liable for any error or omission. However, should any error or omission be notified, the authors will use their best endeavours to correct the information.

Front page photograph: Assessing regeneration of a threatened plant (A Chuter).

Acknowledgements

Many thanks to the large number of people that have contributed to the project summaries covered in this report. The main collaborators are acknowledged in the relevant sections. The full project reports should be referred to for greater detail, ethics approvals, scientific permits and for information on the funders who have supported the projects. We have only supplied information on funders here if no other report or publication is available.

Special thanks to the people who have allowed us to include the results from their research, undertaken independent of the Forest Practices Authority, which provides information that can be used to assess the effectiveness of the *Forest Practices Code* provisions.

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1. Introduction

The overarching objective of Tasmania's forest practices system is to achieve sustainable management of Crown and private forests with due care for the environment. The sub-objective for the management of biodiversity is to conduct forest practices in a manner that recognises and complements the contribution of the reserve system to the maintenance of biological diversity, ecological function and evolutionary processes through the maintenance of viable breeding populations and habitat for all species (Forest Practices Authority, 2015).

The *Forest Practices Code* (Forest Practices Authority, 2015) and associated planning tools deliver a variety of actions that aim to meet the management objective for biodiversity in areas covered by the system. The processes, policies and strategies involved are reviewed in Chuter and Munks (2011). These have been developed from a mixture of expert judgement, practical experience and the outcomes of research and monitoring.

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

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

The Tasmanian forest practices system follows an adaptive management framework which includes an emphasis on research, review and continuing improvement (Forest Practices Authority, 2014). It is widely recognised that ongoing research and monitoring is important for the scientific credibility of the Code's provisions applied in forest management plans (Commonwealth of Australia and State of Tasmania, 1997; Davies et al., 1999; Wilkinson, 1999). There is also a legislative requirement to monitor the effectiveness of Code provisions applied in forest practices plans (FPPs). The Tasmanian *Forest Practices Act 1985* states that, 'the Board must…assess the implementation and effectiveness of a representative sample of forest practices plans'. There is also an obligation to monitor the effectiveness of management actions for threatened species under Clause 7 of the procedures for the management of threatened species agreed with the Department of Primary Industries, Parks, Water and Environment (FPA and DPIPWE, 2014). With ongoing public scrutiny of forest practices in Tasmania, the scientific basis for particular management actions needs to be clear.

Information on the effectiveness of the biodiversity provisions of the *Forest Practices Code* was reviewed in 2012 (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* (FPA, 2012). To identify priority monitoring projects, the management objectives and threats to values were linked with management actions. All threat/action pairs were assessed and ranked according to a range of attributes, such as the proportion of forestry operations or land

area that may be affected, the effort to conduct effectiveness monitoring, the expected effectiveness of management, and degree of uncertainty about whether the management action is effective. This assessment was done both for the general *Forest Practices Code* provisions for biodiversity and the specific management recommendations for threatened fauna delivered via the Threatened Fauna Adviser. See Box 1for the highest priorities for each group of management actions (FPA, 2012). Note that this assessment has not yet been undertaken for the management actions for threatened flora species or communities, but is planned for the next financial year as the Threatened Plant Adviser is developed.

Each year the FPA attempts to implement a number of the priority effectiveness monitoring projects. The actual projects implemented depend on available funds, logistic considerations and staff/student availability.

This report summarises the findings from the projects worked on during the 2014–15 financial year. This report includes projects that have been implemented by the Forest Practices Authority in collaboration with other research providers. Projects implemented by other researchers have also been included if the results contribute information that can be used to evaluate the effectiveness of the actions implemented for biodiversity values, in areas covered by the forest practices system.

Box 1. Project areas identified as a priority to evaluate the effectiveness of the biodiversity provisions of the *Forest Practices Code* (FPA, 2012).

The priorities identified for monitoring the effectiveness of the general biodiversity-related code provisions are:

1. evaluate the degree to which the coupe dispersal guidelines limit the amount of harvesting within a subcatchment and thereby reduce impact on water flow;
2. determine the degree to which mature habitat availability is changing across the forest estate in Tasmania;
3. determine if the hygiene measures help prevent the spread of *Phytophthora cinnamomi ;*
4. determine whether significant habitat definitions for threatened species are adequate;
5. determine whether wildlife habitat clumps help maintain forest birds, hollow users, fungi and bryophytes in forestry areas;
6. 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);
7. determine the degree of mature forest connectivity across the production forest state;
8. determine whether water quality is maintained in streams under current management;
9. determine whether soil productivity is maintained over the long-term by current forestry practices.

The priorities identified for monitoring the effectiveness of the threatened fauna management provisions (note that priorities have not yet been identified for flora) are:

1. assess the effectiveness of giant freshwater crayfish management recommendations for managing changes in stream morphology and water quality;
2. assess the effectiveness of Skemps & burgundy snails management recommendations for managing loss of habitat;
3. assess the effectiveness of grey goshawk management recommendations for managing loss of foraging habitat;
4. assess the effectiveness of keeled snail management strategy;
5. assess the effectiveness of eagle management recommendations for managing breeding failure due to disturbance;
6. assess the effectiveness of grey goshawk management recommendations for managing loss of nesting habitat;
7. assess the effectiveness of swift parrot management recommendations for maintaining breeding habitat;
8. assess the effectiveness of masked owl management recommendations for maintaining potential nesting habitat.

2. Summary report on FPA research and effectiveness monitoring covered in 2014–15

2.1. General *Forest Practices Code* provisions for biodiversity

The focus of work done in 2014–15 that looked at the effectiveness of the general Code provisions for biodiversity was project area 6 and 8 (Box 1).

2.1.1. Assessing the effectiveness of the mature habitat availability map

The FPA mature habitat availability map is a planning tool designed to help FPOs manage this seral stage that is important for hollow-using species (including threatened species) (Forest Practices Authority, 2012). Knowledge of the accuracy of this map is important in order to determine the degree to which it should be used when making management decisions.

The FPA have been undertaking a study to examine the effectiveness of the mature habitat availability map for predicting the availability of hollow-bearing trees in wet *Eucalyptus obliqua* and *E. regnans* forest. The data has been analysed and a manuscript of this work is in draft form.

FPA are also working with ANU researcher Matt Webb and FT staff to investigate the potential of using LiDAR data for mapping mature forest and tree hollow availability. This study is in the conceptual phase.

2.1.2. Wildlife habitat clumps: survival

Wildlife habitat clumps are small patches of trees retained within or adjacent to harvested areas to assist in the *'maintenance of the habitat requirements of oldgrowth dependent fauna species, particularly hollow dependent fauna, and enhance(s) recolonisation of areas following harvesting*' (Forest Practices Authority, 2015). The objective of wildlife habitat clumps can probably only be achieved if suitable trees are retained, and if the trees survive into the long term.

A long-term study was initiated by the FPA in 1999 to look at the mortality rates of trees retained within wildlife habitat clumps in partially logged areas (Duhig et al., 2000). Ten coupes were selected for study, and two to three clumps were established as monitoring sites in each coupe. All eucalypt trees over 10 cm dbh were measured and tagged. These trees were re-surveyed between 2005 and 2009. Between 2006 and 2009 control clumps where established near nine of the coupes (one coupe had no intact suitable forest nearby to use as a control).

In 2013–14 the study clumps were re-surveyed, and in 2014–15the data was proofed. Analysis and writing up will commence in 2015–16.

2.1.3. Effectiveness of stream management for maintaining platypus populations in headwaters (*Ornithorhynchus anatinus*)

Both the guiding principle for biodiversity and the guiding principle for water apply to aquatic species found in forested landscapes such as the platypus. The guiding principle for water, as specified in the *Forest Practices Code* is "*forest practices will be conducted in a manner that does not cause significant deviations from natural ranges for water flow and quality, including natural disturbance events such as wildfires and storms, and meets statutory objectives for water management and water quality standards for human use by minimising the risk of sedimentation and pollution from forestry activities*".

Water quality, channel stability and biodiversity in aquatic systems are protected by minimising disturbance to watercourse channels and soil near watercourses, primarily by managing streamside reserves (Section D2.1, Forest Practices Authority, 2015).

Two projects which will contribute to our understanding of the effectiveness of such actions were current in 2014–15.

The first was a project by UTas Honours student, Tamika Lunn. Tamika commenced a project in 2014–15 to assess whether the stream management provisions of the *Forest Practices Code* are effective at maintaining the distribution and health of one of Tasmania's largest aquatic species, the platypus. Tamika re-surveyed sites in logged and unlogged catchments in the northeast of Tasmania (Ben Nevis region) which had been sampled previously in 2000 by Koch et al. (2006). Data collection is now complete and Tamika will use structural equation modelling (SEM) to assess the direct and indirect factors driving any differences she finds between sites and years. SEM is a powerful multivariate technique that can interpret information about multiple interacting factors in order to evaluate complex causal relationships. This study will contribute to our understanding of the effectiveness of the stream management recommendations in headwater areas for maintaining aquatic fauna.

The second project was a PhD study by James MacGregor on the health, distribution and population density of platypus in two river catchments (Inglis and Seabrook) in the northwest of Tasmania. Platypus distribution and density were investigated in a capture/release study (n=154). The effect of habitat on capture numbers and health parameters was assessed. Reproduction, individual health, genetics and condition were investigated using hormonal, ultrasonographic, haematological and biochemical techniques. In-stream microchip readers were used to monitor platypus movements/survivorship. The results from James's study indicate that platypuses are using watercourses throughout the catchments and appear to favour the more productive lowland river reaches. Capture rates were significantly negatively correlated with amount of forest cover (native and forestry combined) within 500m of fieldwork sites. In-stream microchip readers showed continued use of sites by 80% of platypuses captured during this project, and 42% captured in an earlier study by James in 2008–09. James trapped 154 individuals and found them to generally be in good health. This study provides reliable baseline data for future monitoring of this species and has established a new remote monitoring technique for this species.

These two student projects are collaborations between FPA and UTAS researchers and FPA and Murdoch University researchers, respectively. They were both funded through external sources and Forestry Tasmania and Private Forests Tasmania provided spatial and attribute data on the forest estate during site selection.

Figure 1. Selecting platypus trapping sites in headwater streams in Ben Nevis region. (Photo: E Harris)

2.1.4 Relating forest management to stream ecosystem condition in middle catchment reaches in Tasmania.

Another provision of the *Forest Practices Code* to meet the guiding principle for water and biodiversity is, '*In catchments important for threatened aquatic fauna, management of water supply is to be achieved by minimising as far as practicable the percentage of the catchment harvested, roaded or converted in any one year (Section D2.2 of the Forest Practices Code).'*

A study by Davies et al, completed in 2014–15, provides information that can be used when implementing this provision. This study investigated the relationship between the history of forestry operations in a catchment (both clearfell, burn and sow (CBS) harvesting and conversion to plantation), and instream biota and habitat. Initiated in 2009, the study built on the earlier work of Smith et al. (2009). Study sites were situated in fourth order stream reaches with no adjacent forestry activity, so that impacts represented the accumulated effect of forestry activity in the upstream catchment. The results indicated that in-channel fine sediments increased and the proportion of aquatic insect taxa decreased with increasing percentage land area under CBS. Analysis of the data suggested that roading was a substantive co-contributor to the overall impact of upstream CBS operations. There was no significant relationship between area of plantation and any macroinvertebrate community variable, presumably reflecting the lower levels of sediment deposition observed downstream in the sampled plantation-dominated catchments. A scientific paper on this research has been submitted for publication.

The project is a collaboration between Dr Peter Davies, Laurie Cook and Steve Mallick (Freshwater Systems) and Dr Sarah Munks (FPA). This project was partly funded by Forestry Tasmania and the Co-operative Research Centre for Forestry. Forestry Tasmania and Private Forests Tasmania provided spatial and attribute data on the forest estate during site selection.

2.2. Threatened species management

The focus of work done in 2014–15 that looked at the effectiveness of the provisions for threatened fauna species were project areas 1 and 5 (Box 1).

2.2.1. Management effectiveness for giant freshwater crayfish (*Astacopsis gouldi)*

The giant freshwater crayfish is the largest freshwater crayfish in the world, is endemic to northern Tasmania and is listed as Vulnerable in both state and federal legislation. The major threats to this species are overfishing and loss of healthy stream habitat (Threatened Species Section, 2015b).

UTas Honours student, Andre Pracejus, commenced a project to model habitat suitability and assess the effectiveness of management for giant freshwater crayfish. The program Maxent will be used with spatial information on habitat characteristics and species locality records to model habitat suitability for the species across its range. This model will be used to select study sites in areas of plantation and native forest which will be surveyed for adult and juvenile crayfish. The results of this project may inform a review of management for this species. The project is a collaboration between Andre Pracejus, Associate Professor Leon Barmuta (School of Biological Sciences, UTAS), Dr Amelia Koch (FPA) and Dr Peter Davies (Freshwater Systems). Expert advice on crayfish is being provided by Laurie Cook and Dr Alastair Richardson. This project is being partly funded by Forico.

Figure 2. A training day to help the student learn the crayfish survey techniques. (Photo: A Koch)

2.2.2. Wedge-tailed eagle (*Aquila audax fleayi*) management actions

The Tasmanian wedge-tailed eagle is an endemic subspecies that is listed as endangered at both a state and federal level. The primary threats to this species are loss of nesting habitat, disturbance at the nest site, mortality due to collisions with man-made structures and persecution (Threatened Species Section, 2015a).

FPA initiated a research program in 2007 to monitor the rate of nest success. The annual monitoring was continued in 2014–15 and the rate of nest success was found to be at the lower end of the range observed during the last eight years of survey (Figure 2). The annual nest activity data is also used to estimate the timing of the breeding season, and the 2014–15 season was found to be later than average (Figure 3).

The objective and outcomes from the FPA eagle nest monitoring project were reviewed in 2015 and it was determined that the scale of the project would be reduced due to limited resources. In the future the project will primarily focus on establishing the timing of the breeding season, surveying a reduced number of nests known to have been active in the recent past. The study will continue to collect nest activity data for this reduced number of nests.

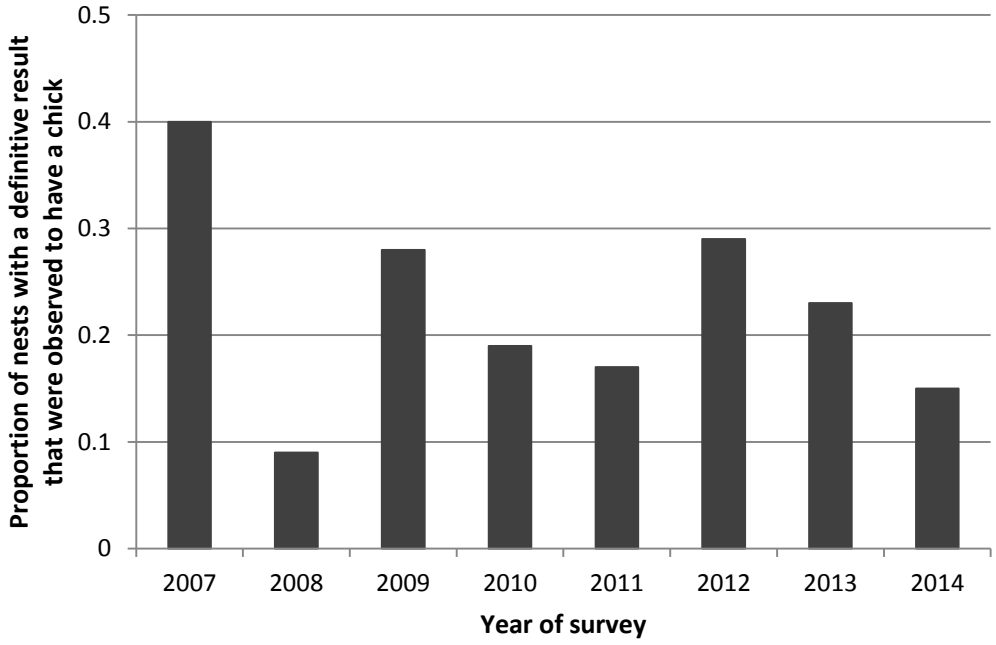

Figure 2. The rate of nest success (proportion of nests with a definitive result that had a chick) during the last seven years of survey. Note: sample sizes vary between years (n = 47, 47, 105, 104, 116, 169, 172, 280 for the successive years).

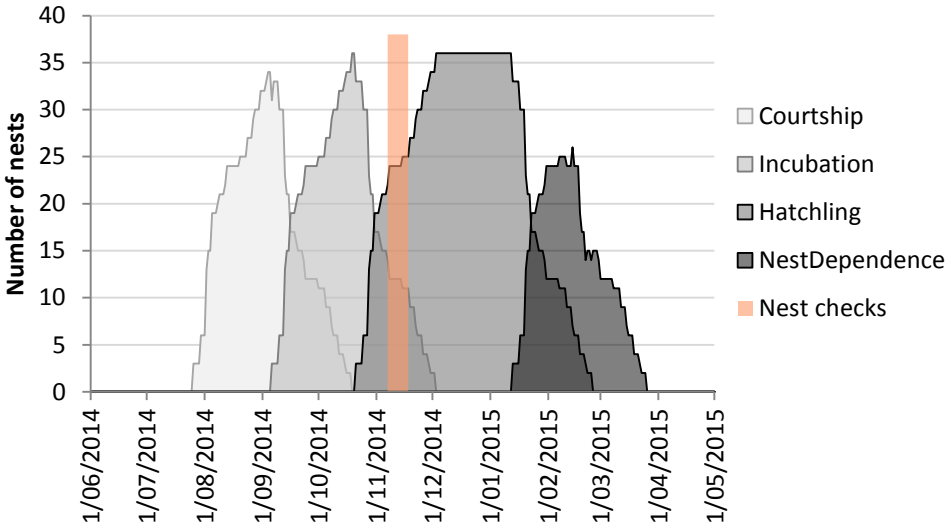

Figure 3. The timing of the 2014–2015 breeding season as extrapolated from the estimated age of chicks at 36 nests. The orange bar indicates the usual time for the November nest checks.

In March 2015 an FPA-supported PhD candidate, James Pay, commenced research with the aim of quantifying the impacts of disturbance on the breeding ethology, spatial ecology and physiology of the Tasmanian wedge-tailed eagle. The project is currently establishing field monitoring techniques. Field methods employed during a related honours project (involving Ethics approved field observations) had a negative impact on the nesting eagles, with a high level of nest failure at study sites (O'Sullivan 2014). To limit any non-experimental disturbance to the nesting eagles the present PhD research utilises a bespoke field camera set-up (Figure 4), designed by Jason Wiersma (FPA). In future breeding seasons cameras will record footage of breeding eagles at 30–40 nest sites, allowing insight into the nesting phenology of *A. a. fleayi* and verification of the breeding schedule. Future work is expected to investigate the specific effects of different types of disturbance at specified distances to establish the efficacy of current nest management regulations (e.g. the 500m management constraint zone around active eagle nests). Disturbances may also be introduced at various phases during the breeding season to elucidate temporal changes in disturbance sensitivity proposed by Mooney and Holdsworth (1991). Additionally, the project may monitor eagle movements with GPS telemetry units to assess how their spatial ecology is affected by disturbance and anthropogenic habitat alteration. Finally, the physiological effects of disturbance may be investigated by using feathers to assess stress hormone levels. Results of the study will improve understanding of the effectiveness of current management for this species and may result in a review of management. The project is being supervised by Professor Elissa Cameron (School of Biological Sciences, UTAS), Dr Amelia Koch (FPA) and Dr Clare Hawkins (Threatened Species Unit, DPIPWE). Expert advice on Tasmanian wedge-tailed eagle ecology and guidance on the project design are being provided by Nick Mooney, Jason Wiersma (FPA) and Bill Brown (DPIPWE). Initial funding for the project has been provided through an industry grant (New Forests/Timberlands).

Figure 4. An example of the box housing a telescope used to monitor nesting behaviour of eagles. (Photo: J Pay)

2.2.1. Management effectiveness of Wally's wattle (*Acacia pataczekii*)

Acacia pataczekii is a shrub or small tree found in north-eastern Tasmania that is listed as rare under state legislation. In 2005 a logging operation was proposed in an area containing *A. pataczekii*. A management approach was developed to minimise the long-term risk to the population within the coupe by maintaining a portion of the large *A. pataczekii* trees on site and monitoring the implementation and effectiveness of the management prescriptions. Ten plots with ten adult (mature) plants each were assessed before logging, immediately after logging and again eight years after logging. Regeneration surveys were done eight years after logging. This study found some damage to the unmarked study plots after logging, but the majority of plots remained intact. High levels of regeneration were found eight years after logging, particularly in plots that did not contain adult plants. This study concluded that the management approach had been implemented correctly and was effective in maintaining this species within the harvested area (Chuter et al., in press). The results of this study can be used to inform future management of this species.

2.2.2. Keeled snail (*Tasmaphena lamproides*) management strategy

The keeled snail is a carnivorous land snail listed as Rare under state legislation due to a restricted range and low population density. A conservation management plan for the species, to be implemented on public land, was developed in 2000 and revised in 2006 (Fauna Strategic Planning Group, 2006). FPA initiated a study in 2013 assessing the effectiveness of a strategic management plan (Fauna Strategic Planning Group, 2006) for the keeled snail (FPA, 2014). This study involved re-surveying sites that had previously been surveyed in 1992. The study was completed in 2014. During 2014–15 FPA has been collaborating with

FT and Kevin Bonham (private researcher) to write the results into a scientific paper on the implementation and effectiveness of management for the keeled snail. This paper is currently in draft form.

2.2.3. Habitat identification for grey goshawks (*Accipiter novaehollandiae*)

Grey goshawks are listed as Endangered under the *Threatened Species Protection Act 1995*, with one of the primary threats to this species being habitat loss (Bryant and Jackson, 1999). FPA have a technical note for identifying potential habitat for this species, which draws heavily on expert opinion and a small amount of research in north-western Tasmania. This technical note needs revision to improve clarity and relevance to areas other than north-western Tasmania. Consequently FPA researchers are starting a project to elicit clearer guidelines on habitat identification for grey goshawks across Tasmania. The first stage of the project will use the technique known as 'expert elicitation' to identify the most important habitat attributes for this species, as understood by the species experts. This information will be used to develop draft habitat identification guidelines, which will be tested in the field by a goshawk specialist. FPA intend to then work with Forestry Tasmania to try and use LiDAR data to model suitable habitat for this species. This project is in the early stages but will help provide clearer guidelines and planning tools for identifying habitat for this species.

2.2.1. Habitat use of plantations by Tasmanian devils (*Sarcophilus harrisii*) and spotted tailed quolls (*Dasyurus maculatus*)

Carnivores play an important ecological role and many species have been shown to be sensitive to habitat change. Two of the marsupial carnivores managed under the forest practices system are the Tasmanian devil and the spotted tailed quoll. The Tasmanian devil is listed as Endangered at both the state and federal level, and the spotted tailed quoll is listed as Rare under state legislation and Vulnerable under federal legislation.

Plantation forestry is a high intensity form of forestry and this study, being undertaken by Joanna Lyall as a Masters by research through the University of Tasmania, aims to examine the landscape and stand level factors that influence the habitat suitability of plantations for these two threatened species. In addition, this study also aims to assess how the occurrence of these two species varies with feral cat densities. Study areas include native forest (both relatively intact and regenerating), plantation forests (including remnant patches of native forest and riparian reserves within plantations) and fragmented forest patches in and around agricultural land. Camera traps were deployed at study sites (Figure 5) during the Autumn/Winter of 2014 and the Spring/Summer of 2014–15. Data collection is complete and data analysis is underway. Preliminary results show that all three carnivores were found from native forest through plantations to agricultural land. Each species, however, shows preferences for particular habitat types. Further analysis may shed light on the habitat requirements for the marsupial carnivores and interactions within and between species. It is hoped that the results of this study will provide some indication of the habitat elements within the landscape that determine how devils and quolls inhabit the area. This study may be used to inform and review the identification and management of suitable habitat for these species within plantation areas.

Figure 5. Tasmanian devil female heavy with pouch young from regenerating native forest behind Loyetea (J Lyall)

3. Other Tasmanian project outcomes that contribute to our understanding of the effectiveness of *Forest Practices Code* provisions for biodiversity in 2014–15

These studies have mostly been done independently of the Forest Practices Authority, but the results have either been published as a thesis or scientific publication or the authors have contacted the FPA. Only a brief summary of the results relevant to the forest practices system are presented here.

3.1. General *Forest Practices Code* provisions for biodiversity

3.1.1. Forest retention measures to promote recolonisation

Forests of different ages provide habitat to different species, and promoting landscape heterogeneity is seen as one of the key strategies for maintaining biodiversity in production forestry landscapes (Lindenmayer and Franklin, 2002). It is particularly important that mature forest is maintained throughout the forest estate as older forests provide special structural features, take long times to develop and therefore are more difficult to replace (Munks et al., 2007). Understanding the spatial requirements of species, particularly in relation to mature forest, can inform both stand and landscape level management to help maintain habitat for biodiversity.

A study by UTas and FT researchers has investigated the influence that adjacent mature forest has on the communities of ground-dwelling beetles in regenerating wet forest. Transects were sampled in three forest age classes at increasing distance to the adjacent mature forest (Fountain-Jones et al., 2015). In the oldest treatment sites (42–46 years since

clearfelling) species considered indicators of mature forest had recolonized to abundance levels similar to those observed within adjacent mature forest stands. However there were significant differences in species composition suggesting beetle assemblages had mostly, but not entirely, recovered. The influence of the adjacent mature forest was estimated to extend 13 m and 20 m in the youngest (5–10 years) and intermediate (23–39 years) secondary forests respectively. Modelling suggests that leaf litter, microclimate and soil variables were all important in explaining the spatial variation in beetle assemblages, and the relative importance of factors varied between secondary forest age classes.

A related study, also done by UTas and FT researchers, investigated the influence that adjacent mature forest has on the communities of birds in regenerating wet forest. Bird surveys were done 35m, 120m and 200m from mature forest (Hingston et al., 2014). No difference in bird assemblage composition, species richness or the incidence of any species was found in relation to distance from mature forest. However there were changes in assemblage composition, native species richness and incidence of 10 species with time since harvest.

The effect of forest influence on bryophytes was also examined by UTas and FT researchers (Baker et al., 2013). In disturbed forest the rate at which bryophytes established on logs and the ground decreased with distance to the mature forest boundary. The influence of the unlogged mature forest on bryophyte establishment was estimated to occur up to 50m into the disturbed area, although species varied in their response. Species relationships between establishment rate and distance to mature forest were stronger on the ground than for log substrates.

All of these studies highlight the importance of forest retention measures and connectivity for maintaining species diversity. The mechanisms by which mature forest can influence disturbed forest are either as a source for recolonization, or by influencing the biotic and abiotic conditions of the disturbed forest. A further study by UTas and FT researchers examined the influence of intact forest on the microclimate of regenerating forest. Temperature, relative humidity, vapour pressure deficit and the short-term fluctuations of these microclimate parameters were all influenced by nearby mature forest. However the magnitude of the forest influence changed over diurnal, seasonal and successional time scales. The impact of forest influence on microclimate peaked about 27 years after harvest in the areas studied, but will still detected in areas 45 years after harvest.

3.1.2. Management of water quality and stream flow

The *Forest Practices Code* recommends implementing streamside reserves and limiting harvesting within a catchment as a means of maintaining water quality and stream flow (Forest Practices Authority, 2015). Forestry Tasmania and Freshwater Systems are undertaking a long-term study, known as the Warra Hydrology Study, to assess the effectiveness of the *Forest Practices Code* class 4 stream prescriptions for maintaining water quality and aquatic communities (Ringrose et al., 2001). This study monitors temperature, pH, conductivity, turbidity, streamflow and macro-invertebrates in gauged weirs on three pristine (or nearly so) class 4 streams. 17 years of before harvest monitoring have been done.

A harvesting operation that intersects two of the catchments is being planned (T. Wardlaw, pers. comm.). The aim is to have a 10m riparian buffer on one creek, a machinery exclusion zone on another, and an unharvested control on the third creek. Note: this work will require a variation to the Threatened Fauna Adviser which has not yet been granted.

Harvesting and growing trees is known to impact water yield within a catchment (Vertessy et al., 2001; Zhang et al., 2010), but determining how to manage catchments to maintain stream flow over the long term is difficult. Plantation forest water use may vary from that of native forests due to different densities of trees and growth rates. Forestry Tasmania conducted research on the water use of *Eucalyptus nitens* plantations to help inform future plantation management. A model of water use, based on basal area data, was developed to enable FT's existing forest estate wood-flow scheduling model to assess the impacts of plantation management simultaneously on wood production and water use (Roberts et al., 2015). The model was constructed from data collected in five plots in young plantations in the Florentine Valley between 2008 and 2010. The predictive ability of the model was tested at plantations at Forestier Peninsula in 2011. This model can be used to optimise harvesting schedules by incorporating water-use constraints into the forest estate model.

3.2. Threatened fauna provisions

3.2.1. Swift parrot (*Lathamus discolor*)

The swift parrot is an endangered species that relies on tree hollows for nesting, and forages primarily on the flowers of *Eucalyptus globulus* and *E. ovata.* Management recommendations for this species in areas covered by the forest practices system are provided in the Threatened Fauna Adviser.

A population monitoring program was established by DPIPWE in 2007 (Webb et al., 2007) and has been continued and the research expanded upon by Australian National University researchers Rob Heinsohn, Dejan Stojanovic and Matthew Webb. Recent work includes the development of species occupancy models and population viability analyses.

Occupancy models for swift parrots were developed from the results of the population monitoring between 2009 and 2012 (Webb et al., 2014). This work confirmed the importance of food availability in determining species occupancy, and demonstrated that the area of occupancy varies annually and in some years is very limited. These models can be used over time to refine the area to which management of the species needs to focus and highlights the importance of managing habitat for this species throughout its range.

Other research by ANU focused on the threat posed to the species by sugar gliders. Swift parrot nests were monitored over three years with cameras. Bioclimatic modelling was used to predict the potential distribution of introduced sugar gliders across the study area and assess the predation risk to swift parrots and other threatened birds using nest-survival analysis. This work highlighted the dramatic impact that sugar glider predation has on nesting attempts, and the importance of offshore islands to the species due to the absence of sugar gliders. On the Tasmanian mainland there was a positive relationship between nest survival

and increasing mature forest cover at the landscape scale, indicating it is important to manage large habitat patches and limit habitat fragmentation (Stojanovic et al., 2014).

Population viability analysis examined the future impact of sugar glider predation on the species and all models showed dramatic decreases in population size over short time spans (Heinsohn et al., 2015). As a result of this work it has been proposed that the status of swift parrots be upgraded from "Endangered" to 'Critically Endangered' under IUCN criteria. The modelled species declines confirm the importance of having effective and comprehensive management for this species.

The research being done on swift parrots confirms the need for landscape-scale management of habitat for this species, and the need for retention of larger patches of intact habitat. This result supports the management approach recommended in the Threatened Fauna Adviser.

3.2.2. Miena jewel beetle (*Castiarina insculpta*)

Miena jewel beetle is an endemic species that is listed as endangered under state legislation. Very little is known about this species, but surveys conducted in 2013 located a number of specimens around the Great Lake area. Species records appear to be associated with *Ozothamnus hookeri* (Spencer and Richards, 2014a). Differences in the number of specimens recorded in 2013 and 2014 suggest there may be considerable fluctuations in population size between years, potentially relating to the flowering intensity of *Ozothamnus hookeri* and the life cycle of the beetle. Disturbance of habitat by fire is likely to be an important management strategy for this species (Spencer and Richards, 2014a). This study can be used to review the habitat definition and range boundary for Miena jewel beetle.

3.2.3. Forty-spotted pardalote (*Pardalotus quadragintus*)

The forty-spotted pardalote is an endangered species that relies on tree hollows for nesting, and occurs primarily in areas that contain white gum *Eucalyptus viminalis.* Management recommendations for this species in areas covered by the forest practices system are provided in the Threatened Fauna Adviser.

A PhD project from ANU has been looking at the ecology of the forty-spotted pardalote. This study monitored a number of nest sites and found that a parasite is considerably reducing nestling survival (A Edworthy pers. comm.). There are no publications available for this work to date. This work may help guide future management of this species.

A study established on Bruny Island in 2012 has assessed whether white gum regeneration can be stimulated in fragmented woodland remnants and as isolated paddock trees (Strutt and Wright, 2014). Management strategies considered include grazing exclusion, and competition manipulation via scalping (removing the top layer of soil and plant roots), burning, herbicide spray and addition of wetting agent. Preliminary results suggest grazing exclusion helps eucalypt germination with the majority of the effect seeming to be attributable to stock rather than native browsers. Scalping and burning appear to promote regeneration. However seedling mortality appears to be high (Strutt and Wright, 2014). This study has implications for habitat regeneration, but is more applicable to agricultural areas rather than forestry areas.

3.3. Other miscellaneous projects relating to Tasmanian forests

A range of other projects are occurring in Tasmania that relate to forests, but not to the effectiveness of the biodiversity provisions of the forest practices system. A subset of these projects is listed below.

Biodiversity

- A recent report has summarised the reservation patterns of Tasmanian vascular flora and native vegetation (DPIPWE, 2015).
- Some research has shown that bracket fungi can provide important habitat for invertebrates in Tasmania (Bashford, 2014).
- Work is underway describing the life history of the green-lined ground beetle (*Catadromus lacordairei*) (Spencer and Richards, 2014b).
- An observation has been provided of an attempt by southern boobook (*Tyto novaeseelandiae*) to predate a chocolate wattled bat *(Chalinolobus morio*), including a discussion of anti-predation strategies by bats (Cawthen, 2014).
- Despite implementation of control programs, hollow-using rainbow lorikeets (*Trichoglossus haematodus*) are persisting in Tasmania and potentially cross-breeding with native musk lorikeets (*Glossopsitta concinna*) (Gordon, 2014).
- New data supports the association between disturbance by fire and enhanced flowering of *Thelymitra* plants (sun-orchids), largely through increased growth of existing plants (Collier and Garnett, 2014).
- A new species, *Lobelia dentata,* has been recognised in Tasmania from a small number of localities on the Freycinet Peninsula (de Salas and Wapstra, 2014).
- Forestry Tasmania have conducted ten years of annual population monitoring of bird and ground-beetle populations in wet eucalypt forest to track baseline trends in these species and potentially relate population changes to landscape changes (T. Wardlaw, pers. comm.).

Forest management

- A program called GAP CLoSR has been developed to help model landscape connectivity and fragmentation for Tasmanian fauna (Lechner et al., 2015).
- A tool has been developed to help policy makers choose cost-effective options for invasive species management (http://www.nerplandscapes.edu.au/SPADE).
- *Eucalyptus obliqua* were found to grow better in organic layer soil than in mineral soil. This study suggests the practice of burning to mineral soil after harvest exposes a poor growth medium likely only partially compensated by fire-induced mineral soil alterations (Barry et al., 2015).
- A study examining the conversion of heathland to shrubland in south-eastern Tasmania suggests that higher frequency planned fire is needed in this area (Bargmann and Kirkpatrick, 2015).

Climate change

- Long-term monitoring across Australia is being done to assess the relationship between tree growth and climate (Sam Wood, Lynda Prior, Helen Stephens and David Bowman unpublished data, UTas).
- A project has modelled the fire danger in Tasmania over the next 100 years (http://www.nerplandscapes.edu.au/publication/fire-danger-tasmania-next-100-years-summary-policymakers) (Fox-Hughes et al., 2014).
- A published paper provides an overview of climate model outputs and issues that need to be considered when applying projections of future climate (Harris et al., 2014).
- A published paper proposes a framework for prioritizing future climatic refugia for plant diversity in Tasmania. The highest-capacity climate-change refugia were found primarily in cool, wet, and topographically complex environments, several of which were identified as high priorities for biodiversity conservation and management (Keppel et al., 2015).

4. Discussion and 2015–16 priorities

In the 2013–14 report there was a focus on the importance of multi-scaled management and it was identified that further work was needed to assess the effectiveness of the multi-scaled approach. In line with this there has been a focus on refining species habitat identification in 2014–15, as habitat suitability maps can help facilitate landscape-scale management while habitat descriptions are important for fine-scale management. Projects are underway to develop or refine habitat suitability maps or descriptions for hollow-using fauna, grey goshawks, giant freshwater crayfish and carnivores in plantations. More modelling of species habitats is planned for 2015 to further facilitate landscape-scale management of biodiversity values.

In addition to habitat identification and modelling, work has also been done looking at the effectiveness of management for aquatic fauna (platypus and giant freshwater crayfish), wedge-tailed eagles and threatened plants. These studies are important and facilitate adaptive management within the forest practices system. The importance of doing baseline ecological research as well as effectiveness monitoring was also highlighted in the last twelve months, with ANU researchers finding that threats to native species are not always obvious and may interact with forestry impacts in complex ways.

The monitoring program for 2015–16 will continue to focus on the effectiveness of the multi-scale approach to managing biodiversity in the production landscape. Project areas 4 and 6 for the general Code provisions (Box 1) will continue to be the focus in 2015–16. Project areas 1, 5, 6 and 8 (Box 1) will be the focus for the threatened species provisions. The priorities for 2015–16 are outlined below.

- Collaborate with other agencies to test if LiDAR data can be used map availability of tree hollows.
- Complete the study examining the survival of trees retained in wildlife habitat clumps.
- Continue working on modelling, mapping, describing and ground-truthing habitat definitions for threatened species.
- Continue the work on eagle breeding behaviour and the effectiveness of management for this species.
- Continue the work assessing the effectiveness of measures to manage giant freshwater crayfish.
- Model the habitat used by grey goshawks (*Accipiter novaehollandiae*) to assess the management approach for this species.
- Determine habitat use and management effectiveness for masked owls (*Tyto novaehollandiae*)
- Examine the effectiveness of skemps snail (*Charopidae* sp. "Skemps") management, by re-surveying historic sites of this species.
- Examine the effectiveness of burgundy snail (*Helicarion rubicundus*) management, by re-surveying historic sites of this species and areas that were recently burnt by wildfire.

In addition, in 2015 the FPA are working to develop a Threatened Plant Adviser, which will deliver management recommendations for threatened plants. Concurrent with the development of this planning tool will be a process to identify and prioritise effectiveness monitoring projects for managing flora.

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