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

2015–16 summary report

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Report to 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: FPA ecologist, Dydee Mann setting up monitoring camera at devil den site in plantation (S Munks).

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.

Citation

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Executive Summary

- The Tasmanian forest practices system follows an adaptive management framework which includes an emphasis on research, review and continual improvement. Information on the effectiveness of the biodiversity provision of the *Forest Practices Code* was reviewed in 2012. The gaps identified were used to prioritise future projects. Work is done each year on a number of the priority projects. The degree of effort depends on available funds, logistic considerations and staff/student availability.
- This report summarises projects by FPA staff and students (in collaboration with other research providers), carried out during the 2015–16 financial year (Section 2). It also includes projects done by other researchers (independent of the FPA) (Section 3), where the results contribute to our understanding of the effectiveness of actions taken for biodiversity values.
- Three FPA projects current in 2015–16 contributed to our understanding of the effectiveness code provisions relating to the maintenance of species dependant on mature forest and freshwater habitats. Testing of a map of mature habitat availability found that it was useful when planning at a large spatial scale. A long term study of wildlife habitat clumps found that they provided habitat and can survive for at least 16 years in partially harvested coupes. The results from a student project suggest that a platypus population had not significantly changed despite intensive forestry operations in the river catchment over a 15 year period.
- There were nine FPA projects current in 2015–16 which contributed to our understanding of the effectiveness of code provisions for threatened species. Spatial habitat models, for use in landscape-scale planning, were developed and reviewed by experts for 14 threatened species. A study on the giant freshwater crayfish highlighted the importance of sample size when attempting to answer questions relating to effectiveness. Eagle projects found that the timing of the season in 2015–16 was similar to the average for the previous nine years and that nest characteristics could be used to assess use and condition for strategic planning. Preliminary results from surveys of threatened snails indicate that they are found in a wider range of habitats than previously thought. Two studies explored the use of plantations by threatened carnivores (devils and quolls) and other mammal fauna. Preliminary results indicate that species diversity may return to pre-harvest levels in some plantation areas within 4-5 months.
- A range of projects done by other researchers in 2015–16 contributed to our understanding of the effectiveness of forest retention measures to promote recolonisation, the effectiveness of streamside reserves, adequacy of gene flow, effectiveness of threatened species management, edge effects and general forest ecology and management.

1. Introduction

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'. In addition, 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) requires monitoring of the effectiveness of management actions for threatened species. 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* (Forest Practices Authority, 2012a). 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 recommendations for threatened fauna delivered via the Threatened Fauna Adviser. See Box 1 for the highest priorities for each group of management actions (Forest Practices Authority, 2012a). Note that this assessment has not yet been undertaken for the management actions for threatened flora species or vegetation communities. This is planned for 2016–17 when the review work for the development of the Threatened Plant Adviser has been completed.

Work is done each year on a number of the priority effectiveness monitoring projects. The degree of effort depends on available funds, logistic considerations and staff/student availability.

This report summarises the findings from the projects current during the 2015–16 financial year. It includes projects undertaken by FPA staff (mostly in collaboration with other research providers) (Section 2) and projects done by other researchers (independent of the FPA) (Section 3) where the results contribute to our understanding of the effectiveness of actions taken 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* (Forest Practices Authority, 2012a).

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 estate;
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 and 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 2015–16

This section provides short summaries of projects that FPA staff have been involved in.

2.1. Objectives of the Tasmania's forest practices system for biodiversity - What are we aiming for?

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, 2015a).

The *Forest Practices Code* (Forest Practices Authority, 2015a) 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.

The following sub-sections in this report provide a brief summary of the projects current in 2015–16 which contribute to our understanding of the effectiveness of the actions and will inform any future review of the Code provisions.

2.2. General *Forest Practices Code* provisions for biodiversity

The following summaries are for projects that contribute to project areas 2, 5, 6 and 8 (Box 1).

2.2.1. Assessing the effectiveness of the mature habitat availability map

Structural features found in mature trees and forests, such as tree hollows, large coarse woody debris and large spreading crowns, provide critical habitat features for a wide range of species. Some of these features can take hundreds of years to develop and so require consideration in forest management plans to ensure their continued availability, particularly in production environments such as areas used for timber harvesting. Managing a landscape for these structural features is facilitated by planning tools, such as maps reflecting the distribution of mature forest habitat at relevant spatial scales.

The FPA mature habitat availability map (MHAM, Figure 1) is designed to help FPOs manage these mature forest structures when planning forest practices (Forest Practices Authority, 2012b). 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.

A paper was prepared in 2015–16 describing the development and ‘testing’ of this map. Spatial data on vegetation type, mature crown density and senescence, a global layer of forest loss data derived from satellite imagery, a database on historical and current timber harvest plans and a spatial layer on the extent of fire were used in the development of the map. The relationship between tree hollow availability in wet forest areas and mapped mature habitat availability (high, medium, low or negligible) was explored, complementing a similar published study in dry forests. The number of large trees likely to have hollows significantly increased with mapped mature habitat availability, although there was considerable variation and overlap between map categories. Data from a fauna locality database and two radio-tracking studies showed that 5 of the 7 hollow-using species examined (including birds, bats and a possum species) were more likely to occur in areas of higher mapped mature habitat availability. There was no evidence that saproxylic species preferentially used some MHAM categories more than others, although none of the four species examined were dependent on large coarse woody debris. The Tasmanian MHAM will be useful when managing mature forest habitat (tree hollows and large crowns in particular) at large spatial scales, but the variable accuracy of the map needs to be taken into account when planning at fine scales.

FPA staff 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 was progressed by FT staff in 2015–16 and a draft predictive map has been developed (L. Clark, pers. comm.).

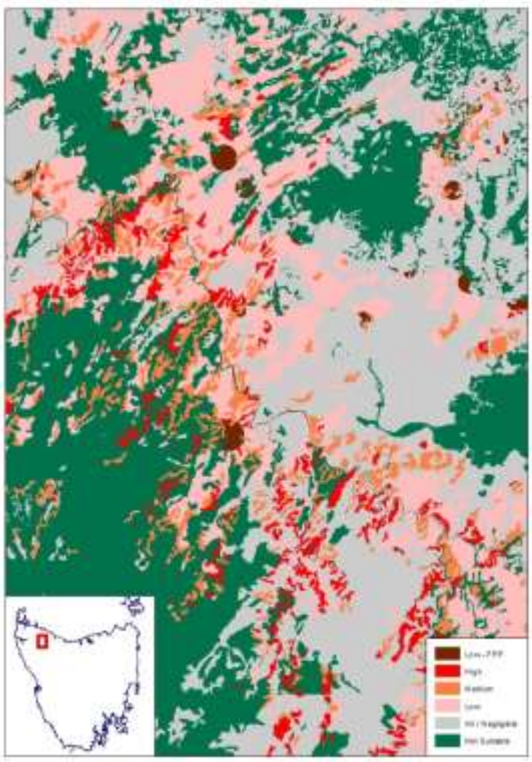


Figure 1. Example extract of the MHAM map for Tasmania. (Map: Dan Livingston)

2.2.2. 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, 2015a). The objective of wildlife habitat clumps can 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 1998 to look at the mortality rates of trees retained within wildlife habitat clumps in partially logged areas (Duhig et al., 2000). Ten partial harvest coupes were selected for study, and two to three clumps were established as monitoring sites in each coupe (27 small wildlife habitat clumps). All eucalypt trees over 10 cm dbhob were measured and tagged. Between 2006 and 2009 control clumps in unharvested areas were established near nine of the coupes (one coupe had no intact suitable forest nearby to use as a control).

Clumps in harvested sites were surveyed on three occasions (1998, 2005 and 2014) and unharvested sites on two occasions (2005 and 2014). 96% of the clumps retained in harvested areas contained at least two habitat trees, the minimum required under the *Forest Practices Code*, at the time of first survey (one year after harvest). Loss of retained trees was higher in harvested (average of 6.4% of trees per clump after 6 years) than unharvested sites (2.8%), but was comparable to or lower than rates of loss in many other studies. Trees were more likely to be lost (due to tree collapse, fire or felling) if they were dead and had little burn damage at the time of last survey. Scratch marks from arboreal mammals were more prevalent in large trees with visible hollows, particularly in harvested areas. Analysis was completed in 2015–16 and a paper prepared for publication. In conclusion, the management provisions in the Forest Practices Code were generally implemented as required and the minimal evidence available suggests the retained clumps of trees are effective to some degree at providing habitat and promoting recolonisation in partial harvest coupes. However further work is required to assess the adequacy of the management provisions, when combined with management actions for other values, for maintaining hollow-using fauna in the production forest landscape.

Figure 2. Wildlife habitat clump with 'habitat tree' in GA102 in 1998 (left) and 2014 (right).

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

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 maintaining streamside reserves (Section D2.1, Forest Practices Authority, 2015).

Two projects which contribute to our understanding of the effectiveness of such actions were completed in 2015–16. A summary of the results from the first, by James MacGregor, was provided in the 2014–15 summary report (Forest Practices Authority, 2015b).

The second project by an honours student from the University of Tasmania, Tamika Lunn, looked at platypus occurrence in the Upper Esk river catchment, 15 years after an earlier FPA–supported study by Nina Koch. Tamika explored the factors influencing use of streams by platypuses in a catchment, including forestry disturbance.

Nina's study in 2000 found that despite a long history of forestry disturbance, platypuses inhabited the small streams in the catchment, with the larger small streams (class 3) being used more often than the small headwaters (class 4). However, the animals she caught in the small headwaters were mainly sub-adults and adults in poor condition and they appeared to avoid streams heavily disturbed in the 1980s by the pre-code logging practices. Tamika's follow-up study, in the autumn and winter of 2015, didn't recapture any individuals from the 2000 study, but her capture numbers confirmed the presence of a similar sized platypus population. She also confirmed Nina's finding, that the platypus prefer the larger streams, but will occasionally use the small headwaters.

Using structural equation modelling and combining her data with Nina's, she showed that use of streams by platypus in the Upper Esk sub-catchment is influenced primarily by both local and catchment factors, and to a lesser extent disturbance through forestry operations. For example platypuses avoided streams which locally had a lot of fine sediments and barriers to movement, and where the overall catchment area was small and where there were barriers to movement at the sub-catchment scale. Her analysis showed that while forestry activities, such as harvesting and roading, resulted in disturbance to local stream habitats (e.g. bank erosion, in-stream material) they had little effect on the use of the streams by the platypus. She found that the degree to which local, catchment and forestry disturbance variables influence the presence of platypus varies according to the position of the stream in the broader river catchment. Local features such as the stream substrate, bank characteristics and presence of sediment, were most important in headwater streams, followed by disturbance factors and catchment factors (such as stream order, catchment area, and distance to a larger stream). Whereas catchment factors were most important when considering stream use at the larger sub-catchment scale, local habitat features and disturbances from forestry operations were less important at this scale.

Tamika's study suggests that the population of platypus in the Upper Esk catchment has not significantly changed over the last 15 years, despite the long term forestry operations in the catchment. This may reflect both the improvements made to management practices and the resilience of this species to environmental change.

Figure 3. Tamika and Sarah recording the weight of a platypus caught in a small stream at Upper Esk. (Photo: Dydee Mann)

2.3. Threatened species management

The following summaries are for projects current in the 2015–16 financial year that looked at the effectiveness of the provisions for threatened fauna species. They contribute to threatened fauna project areas 1, 2, 4, and 5 (Box 1).

2.3.1. Developing spatial habitat models for threatened fauna

Many of the priorities identified for monitoring the effectiveness of the threatened fauna management provisions (Box 1) require an understanding of species habitat characteristics and distribution.

In September 2015, conservation scientists from the Forest Practices Authority and Forestry Tasmania developed draft spatial models of Tasmanian threatened fauna potential habitat (Yee and Koch, 2016). The process involved reviewing existing habitat models, producing draft habitat models (based on agreed habitat descriptions), seeking expert feedback, refining models, and documenting metadata associated with the resultant models.

Habitat models were developed for 14 threatened fauna species. Species included were those that have habitat requirements that can be mapped and managed at a landscape scale. Species were not included if they had existing habitat models (e.g. giant freshwater crayfish, wedge-tailed eagle, simsons stag beetle), are rarely found in forestry areas (e.g. burrowing crayfish, New Holland mouse), have very localised populations that require local scale management (e.g. freshwater snails, frogs), or whose habitat types would be difficult to model (e.g. spotted- tailed quoll, Tasmanian devil).

Feedback received during an expert workshop was used to refine the models and document the level of confidence and anticipated use through the Forest Practices System. An ‘Access’ database has been developed to facilitate the administration, management and updating of models over time.

2.3.2. 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 illegal fishing and loss of healthy stream habitat.

University of Tasmania student, Andre Pracejus, completed his Honours project which aimed at modelling habitat suitability and assessing the effectiveness of management for giant freshwater crayfish. The study compared the abundance of juvenile giant freshwater crayfish in small (Class 4) streams draining catchments consisting of ‘old growth’ forest, and two different plantation types (eucalypt and radiata pine) in north-western Tasmania. An initial pilot study revealed many small streams listed in CFEV as potentially supporting this species were temporary streams. To improve the cost-effectiveness of sampling, we used species distribution modelling (MaxEnt) and variables mapped in CFEV and related databases (e.g. NVA) to improve predictions of where this species may be found (habitat suitability for the species across its range). While this reduced the probability of including temporary streams, there were few small, permanent streams draining catchments that were purely one of the forestry types. This, combined with access problems, resulted in only 7 ‘old growth’, 5 eucalypt and 10 pine streams being surveyed. There was no strong association in either abundance or presence/absence of juvenile crayfish with forestry type. This does not mean that forestry has no impact on this crayfish. Retrospective power analysis suggests that 15 – 18 streams per forest type would be needed to reliably detect an effect as large as the biggest difference observed in the data set. Such sample sizes may be difficult to achieve in practice because many catchments large enough to potentially support this species have a mixture of forestry types within them. Moreover, exploration of the data suggested that small-scale habitat features (e.g. log jams, undercut banks) may be important in harbouring crayfish, and that sedimentation may improve the detection of juvenile crayfish – but is unlikely to be beneficial to their long-term prospects. The results of this project are being expanded upon to further inform 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 4. Andre with giant freshwater crayfish at one of his study sites. (Photo: A Koch)

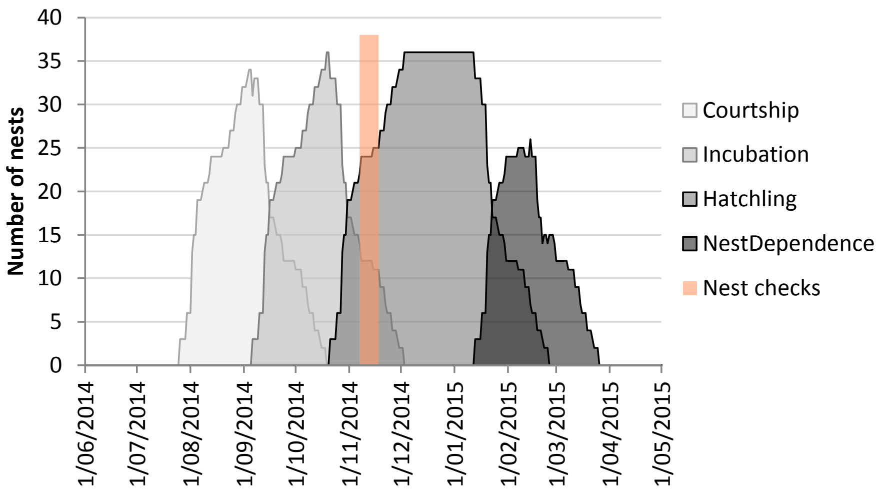
2.3.3. Wedge-tailed eagle (*Aquila audax fleayi*) management actions

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, 2015). Three projects were current in 2015-16 which contribute to our understanding of the effectiveness of management actions for this species.

FPA Annual Nest Monitoring

FPA initiated a research program in 2007 to monitor wedge-tailed eagle nests and data was collected between 2007–08 and 2014–15 on the rate of nest success and timing of breeding season events (Forest Practices Authority, 2015b). The objectives 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 FPA resources. In 2015–16 the project, therefore, aimed to only establish the timing of the breeding season to assist with management decisions. A reduced number of nests (21) were surveyed from the air in November. These were selected from a targeted group of nests confirmed as 'active' from the industry activity nest checks conducted earlier in the season, during October. The data collected from the aerial surveys of these 21 nests was used to estimate the timing of the breeding season in 2015–16 (Figure 5b). The timing of the season in 2015–16 was found to be similar to the average recorded over the nine year study and slightly earlier than the 'later than average' season in 2014–15 (Figure 5a).

(a)



(b)

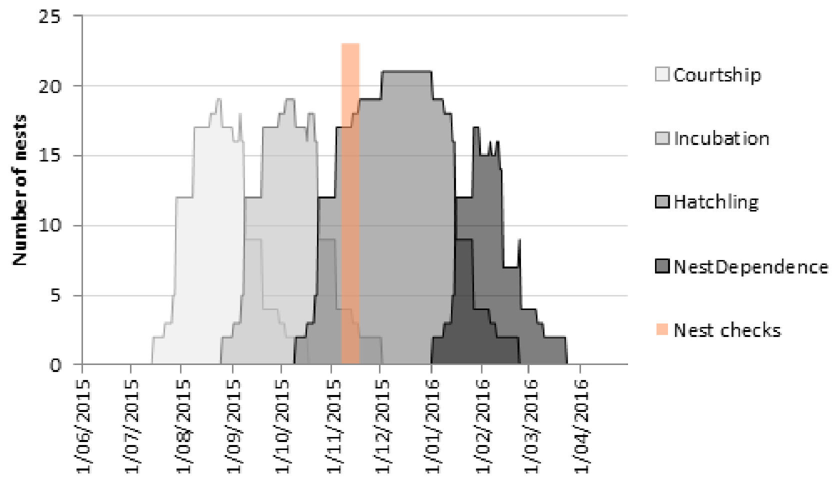


Figure 5. The timing of the (a) 2014–15 and (b) 2015–2016 breeding season, extrapolated from the estimated age of chicks at 36 nests (a) and 21 nests (b). The orange bar indicates the timing of nest checks.

Behaviour of breeding eagles and the impact of disturbance

In March 2015 an FPA-supported PhD candidate, James Pay, commenced research with the aim of studying the behavioural ecology the Tasmanian wedge-tailed eagle and quantifying the impacts of human disturbance. During the 2015 breeding season the project focused on designing and implementing a field camera set-up (Figure 6 and 7). However, the technology wasn't yet capable of achieving the requirements of the study. The main issue was the trade-off between data storage and powering the set-up. The majority of the study nests would be in very remote locations with no power source (except solar energy) or ability to transmit the video footage. Therefore, in order to change over batteries and memory cards the research team needed to visit each site multiple times during the breeding season. These visits could potentially cause significant disturbance to the nesting eagles, impeding our ability to study their behaviour and experimentally assess the impacts of disturbance. As a result the design and methods were reviewed in 15/16 and the project is now following an alternative approach in order to assess the impacts of disturbance.

Data from aerial nest surveys carried out by the FPA will be used to monitor the impacts of an introduced disturbance at the study nest sites. The nests will be surveyed via fixed-wing aircraft in mid-October. These surveys will identify a sample of nests where birds are actively incubating. At half of these nests a human disturbance event will be introduced at the limit of current regulations (500m from the nest). A second aerial nest survey will then be carried out in mid-November to assess if there has been an impact of the introduced disturbance.

The project will also be investigating eagle movements. Studying the movements of wedge-tailed eagles will identify the landscape and habitat characteristics that the eagles use, enabling the prediction of where changes in land use will have the greatest and least effects on the eagle population. The project team will be placing GPS telemetry units on eagles in December 2016. These units will function for a number of years and will provide valuable information on the dispersal patterns, causes of mortality and habitat requirements of the species.

Results of the study will improve understanding of the effectiveness of current management for this species. 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 Jason Wiersma (FPA), Nick Mooney and Bill Brown (DPIPWE). Current funding for the project has been provided through the Holsworth research endowment, Birdlife Australia, the FPA, New Forests through Timberlands Pacific and Norske Skog.

Figure 6. Image showing two chicks being fed at one of the study nests during the 2015-2016 breeding season. This image is taken from the time-lapse footage recorded during the project. (Photo: James Pay)

Figure 7. Setting up a telescope to monitor nesting behaviour of eagles. (Photo: Elizabeth Sheldon)

Strategic eagle nest management 2015 – 2016

This project is being carried out by FPA Scientific Officer, Jason Wiersma. A plan for this project was finalised in 2015–16 identifying key questions, project costing and milestones. The aim of the project is to develop a method to strategically manage eagle nests in production forests. Stakeholder and steering committee groups were formed with the first steering committee meeting held on the 29th September 2015 to assist in the refinement of the projects methods and milestones prior to field work. On the 21st March 2016 a stakeholder group meeting was held to introduce the project and report on the progress and likely outcomes from this work. The field survey work, a pivotal part of this project, was conducted in the study area during April 2016 with follow up ground assessment to locate missing nests. A total of 110 nest sites (and their reserves) were flown during the survey period using rotor-wing aircraft. From these only 77 nests were present, 33 nests were confirmed as gone through ground surveys as a result of natural attrition, mainly through strong winds and falling limbs.

Data was gathered on the 77 extant nests and analysed to test the feasibility of developing a method to assess nest use and condition so that eagle nests in production forests could be strategically managed into the future. Nest characteristic data was collected using direct observation and photographs during the rotor-wing surveys. These data were then analysed to see if the information contained within the photos could be used to reliably determine nest status when compared to direct observation during flight. So that the two methods could be compared experts produced a ranking system based on nest characteristics common to certain nest uses. The results to date show that photographs can be used to rank nests.

During 2016 – 2017 a final stakeholder and steering committee meeting will be held and a report will be developed detailing the feasibility of the methods.

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

Listed as rare on the Tasmanian, *Threatened Species Protection Act 1995*, the carnivorous keeled snail is restricted in range to an area of approximately 1150 km^2 in the northwest of Tasmania, with a low population density. A conservation management plan for the species, for public land, was developed in 2000 and revised in 2006 (Fauna Strategic Planning Group, 2006). A study initiated by the FPA in 2013 aimed at assessing the effectiveness of the plan (Forest Practices Authority, 2014). Sites previously surveyed in 1992 were re-surveyed in 2013. The need for more site replication was identified and subsequent surveys are planned for late 2016; repeating the methodology at a new suite of sites which complement those already sampled. FPA is 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.

Figure 8. A keeled snail in its favourite leaf litter habitat in NW Tasmania. (Photo: Perpetua Turner).

Figure 9. FPA ecologist, Kirsty Kay searching for the elusive keeled snail (Photo: Perpetua Turner)

2.3.5. Skemps snail (*Charopidae sp "Skemps"*) management strategy

Skemps snail is a tiny snail found only in a small area of north-east Tasmania around Mount Arthur (Figure 8). Habitat includes wet sclerophyll forest, closed broadleaf shrubbery, mixed forest, rainforest, and wet or damp forest gullies in predominantly dry forest. Due to the narrow area, intense plantation development within the range, and the thought that Skemps snail was confined to riparian vegetation, the species was listed on the schedule of the Tasmanian Threatened Species Protection Act 1995. Further collecting found Skemps snail in a wider range of habitats including forest logged over 50 years ago or regrowth forest aged over 30 years after mild wildfire, but no records exist for plantations. The abundance and reliability of occurrence, and the full range of habitat types are unclear. The primary management objective for this species, as specified in the 2014 version of the Threatened Fauna Adviser, is 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. The FPA in collaboration with FT and Kevin Bonham is currently writing the results of a study into a scientific paper. The paper examines sampling areas within the potential range of the species, targeting areas of varying levels and types of retention, to determine how the presence and abundance of the species varies in relation to retention methods.

Figure 8. Skemps snail found only in a small area of north-east Tasmania around Mount Arthur.

2.3.6. Habitat use in 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. Two studies that contribute to our understanding of habitat use in plantations by these species were current in 2015 –16.

Responses of native and introduced carnivores to habitat change and fragmentation in northern Tasmania

The first is the study, being undertaken by Joanna Lyall as a Masters by research through the University of Tasmania. This study 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 natural forest patches in and around agricultural land.

Occupancy and abundance data on the target species across native forest, plantation forests, agricultural land and native grasslands/moorlands have been collected, and are testing the effects of habitat variables on each species. Reconyx™ infra-red cameras were set for a minimum period of 21 days at 150 sites during autumn/winter 2014 and again during spring/summer 2014/15 (Figure 9). Site features and landscape factors were recorded within buffers of 1 and 3km around each camera station. Initial analysis indicates substantial differences in the way the three target species use this landscape. Cats have a preference for agricultural sites, being present at 80% of these during winter. Devils and spotted tailed quolls were both found at over 50% of native forest sites in winter and at fewer agricultural sites. Occupancy modelling indicates strong relationships between species, with occurrence of other species and site factors influencing detection and presence. Identification of factors influencing occupancy has the potential to guide modification of land management, particularly in plantations, to maximise opportunities for spotted tailed quoll and Tasmanian devil populations to persist.

Figure 9. Joanna Lyall setting up a camera trap in regrowth native forest (wet *E. obliqua*) in NW Tasmania, to survey quolls, devils and feral cats. (Photo: Jim Lyall).

Use of devil dens in plantations before and after harvest

A small cave in a Norske Skog pine plantations, was recognised by planners in 2014 as a potential den site for the Tasmanian devil. This was confirmed by FPA ecologist, Dydee Mann through the use of a remote camera. The video footage of the cave showed a female devil with young entering, then later leaving without the young. Management prescriptions were developed to protect the site and the devils occupying it, during a harvest operation planned for 2015, including a speed limit for passing vehicles. Harvesting of the 110ha coupe began in the furthest end of the coupe in 2015, with the trees around the den site itself harvested in February 2016.

Monitoring of the den site by Dydee Mann pre and post-harvest involved data collected at monthly intervals using cameras to record observations of fauna visiting the site. Nearly all of Tasmania's larger terrestrial mammals were recorded at the site - including echidna, brushtail and ringtail possum, pademelon, wombat (Figure 10), devil, eastern and spotted tailed quoll, feral cat, introduced rats, introduced mice, antechinus and swamp rat. Individual devils have been recorded returning to the site over multiple months within the same year, in two successive years, and one individual was recorded in 2014, 2015 and 2016. This indicates some devils are resident and others passing through. Although observed species diversity declined post-harvest, species diversity was returning to pre-harvest levels within 4-5 months, including observations of a Tasmanian devil with pouch young entering the den.

Additional monitoring sites were established in the Florentine in 2016 as part of a UTas third year student project (Hannah Waterhouse) (Figure 11) and internal FPA funding was allocated to continue the work until 2018–19.

Figure 10. Wombat caught leaving the den site in the Norske-Skog plantation. (Photo: Dydee Mann)

Figure 11. University of Tasmania student, Hannah Waterhouse, setting up a camera trap to monitor a potential den site in the Florentine. (Photo: Dydee Mann)

3. Other Tasmanian project outcomes that contribute to our understanding of the effectiveness of *Forest Practices Code* provisions for biodiversity in 2015–16

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. Effectiveness of 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.

Studies which are underway or were completed in 2015-16 include -

A cross-continental study of plant and beetle responses to retention of forest patches during timber harvest

Temperate and boreal forest types across three continents was studied for differences in species richness and composition of vascular plants and beetles, between intact (mature) and harvested (regenerating) forest (harvests were conducted in younger or mature forests, except for old-growth Tasmanian sites) (Baker et al 2016). The study included examination of the capacity of retained patches of unharvested forest (aggregates) within the regenerating area to retain species, and the influence of the aggregates and intact forest on the regenerating forest (forest influence) and their susceptibility to the effects of edges (tested only with plant composition). Vascular plants and beetles responded similarly to aggregated retention, and aggregates were not compromised by edge effects, and exerted a positive influence for all surrounding regenerating forests, except for the Tasmanian forests. The harvests in younger or mature forests have fewer specialist and sensitive species, and this may explain the positive result for aggregates (the Tasmanian harvested forests were old-growth prior to harvest). Forest influence into regenerating forests was more common than edge effects, but was not observed in Tasmania. The results demonstrated that for the young and mature forest harvests, the forest within the aggregates was successfully providing a ‘lifeboat’ function for these species, supporting the effectiveness of this production forestry method for the maintenance of biodiversity. Long-term refuge still requires investigation.

The effectiveness of streamside versus upslope reserves in conserving log-associated bryophytes of native production forests.

Log-associated bryophytes of streamside reserves and upslope habitat were the focus of a University of Tasmania and Forestry Tasmania study (van Galen et al. 2016) aimed at assessing the effectiveness of streamside reserves for log bryophytes. Ten sites of mature wet *Eucalyptus obliqua* dominated forest regenerating after at least 56 years old through to old growth, with channel widths ranging from 1 – 10 m, and with both streamside and upslope forest were sampled. Paired areas were sampled within each site; approximately 10 m from the stream bank (and therefore within the 20-40m streamside reserve) and approximately 100 m perpendicular to the stream bank (harvested zone). Logs of at least 30cm diameter and decay class 2 or 3 were sampled for percentage cover of bryophytes in each streamside and upslope area. Thirty percent of bryophytes observed at the streamside were not observed upslope; for most sites, upslope communities were a subset of nearby streamside communities. More species were present at streamsides than upslope but community composition did not differ. Two moss species were indicative of log-upslope/streamside-habitat; one upslope and one streamside. Current Forest Practices Code provisions appear to be effectively conserving log-bryophyte biodiversity.

Early impacts of disturbance on lichens, mosses and liverworts in Tasmania's wet eucalypt production forests.

A thirteen year study (commencing in 1997) into the early impacts of disturbance on lichens and bryophytes in Tasmanian wet eucalypt forest by Kantvilas et al. (2015) is the first long-term pre and post-harvest study including both bryophytes and lichens in Australia. The eighteen plots included 12 with pre and post-harvest data and total of plots were spread over eight coupes and were sampled at approximately 1, 3, and 5 years post-harvest. Presence/absence data were analysed according to felling and burning. Lichen and liverwort floras were the most sensitive groups to disturbance (felling and burning) with significant reductions in species numbers post-harvest. The effects of felling and burning on the persistence of the cryptogam flora were not considered benign given that some species could be at risk of exclusion from wood production areas due to a combination of habitat/substrate loss, unfavourable rotation times, and the extremely slow re-establishment rates of cryptogams.

Temporal persistence of edge effects on bryophytes within harvested forests.

Research by Thomas Baker and colleagues based at the University of Tasmania and Forestry Tasmania, investigated the effect of forest edges (forest influence) on biodiversity, including bryophytes (Baker et al. 2013, 2016a,b). Forest influence includes the mechanisms by which mature forest can influence disturbed forest, either as a source for recolonization, or by influencing the biotic and abiotic conditions of the disturbed forest.

Baker et al. (2016a) used a chronosequence to assess the effect of forest edges on soil and log bryophytes after clearfell, burn and sow native forest harvesting. Analyses combined log and soil bryophytes. For sites from all age classes, sites closer to a mature forest edge had greater affinity in log-soil bryophyte community composition with mature forests. Forest influence was found to persist through time; maintenance of mature forest for the lifetime of harvesting rotations may be required for effective management of log-soil bryophytes, which provide habitats for other components of biodiversity.

Microclimatic edge effects in a recently harvested forest

Focused within a single south facing site in the southern Tasmanian native forests, using data-loggers and automatic weather station data, Baker et al. (2016b) examined the influence of intact forest on the microclimate of patches of forest (aggregates). It was found that in maximum shaded areas, aggregates created similar microclimatic levels to those found in mature forest. Assuming that forest influence is one tree height (a measure used by harvesters in management), the present study showed that when disregarding temporal variation, this estimation is an effective measure for microclimate; the average daily peak in depth of forest influence throughout the study period was around 40 m.

3.1.2 Assessing and managing the risk of gene flow from plantations into native forests.

Eucalypt species are often capable of cross-pollination within related groups. Such crossing, termed hybridisation, can result in viable hybrid offspring. Such hybrids are sometimes observed in nature or in seed collected from native trees where compatible species naturally co-occur. Hybridisation is a natural process and has played a role in the evolutionary history of eucalypts. Nevertheless, hybridisation can be problematic when the natural distribution of a species is greatly extended by human activities.

The Forest Practices Code has provisions to ensure that conservation of genetic resources is considered in the planning of forest practices and Technical Note 12 was developed to provide more guidance on the management of exotic gene flow. A paper published in 2016 summarises the research carried out over a ten year period which provides the biological data needed to help assess and manage the flow of genes from hardwood plantations into adjacent native forest (Larcombe et al. 2016). This paper also highlights future issues, including the need to re-assess the consequences of exotic gene flow in light of global climate change.

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, population viability analyses and studies on life history strategies.

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.

Continuing on from studies on food availability, Stojanovic et al. (2015) investigated the nomadic migrant life history pattern of the swift parrot. They linked broad-scale data on spatiotemporal fluctuation in food resources to data on settlement patterns and fitness outcomes. The study found that fluctuations in food resources were dramatic and influenced breeding patterns, with nesting failure in regions where food resource decreased. By exploiting rich feeding areas, swift parrots maintained stable fitness outcomes between discrete breeding events at different locations.

The future suitability of climate for the swift parrot was modelled taking into account its primary food source and habitat, and the introduced predator the sugar glider (Porfirio et al. 2016). The authors used ensembles of species distribution models based on a climatically down-scaled regional climate model and results were combined with mature forest and fire danger layers.

The results of this and previous research on swift parrots reinforce the need for landscape-scale management of habitat for this species, and the need for retention of large patches of intact habitat. The management recommendations delivered through the Threatened Fauna Adviser are supported by this research.

3.2.2. 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.

An ANU PhD project, looking at the ecology of the forty-spotted pardalote, is published in three peer-reviewed articles. Edworthy (2016a) looked at competition for tree hollows, at the location of major populations of this species, across three islands, (Maria, Bruny and mainland Tasmania). Forty-spotted pardalote never usurped striated pardalote nests, however striated pardalotes were found to reduce breeding success of forty-spotted pardalotes: ~10% of forty-spotted pardalote nest sites across all study areas were usurped, and on mainland Tasmania up to 17% of cavities. Nest boxes were suggested as a solution, with placement and design focused on minimising interspecific competition and experiments on nest-box entrance diameter. Long term solutions include regeneration of mature habitat.

Two 'first reports' were recorded by Edworthy (2016b) and Case and Edworthy (2016). Monitoring of a number of nest sites found the first observation of an endemic Tasmanian fly species, *Passeromyia longicornis*, parasitising the forty-spotted pardalote (87% prevalence across nests; 85 ±5% (s.e) mortality) and the striated pardalote (88% prevalence; 65±6%). Nestling mortality was frequently associated with ectoparasitite presence. The study also found the fly larvae parasitising New Holland honeyeaters, but this was previously known. The first report of 'mining'– birds actively stimulating manna production rather than opportunistic feeding – as a feeding behaviour, is detailed in Case & Edworthy (2016). Manna production in *Eucalyptus viminalis* is stimulated by adult forty-spotted pardalotes clipping leaf stalks with their bills; experiments confirmed this with 53.7% of incisions inciting manna flow in 3 days yet no flow in three other common tree species (*E. pulchella, E. obliqua, E. globulus*). The study established that restoration of *E. viminalis* forests are critical for populations of forty-spotted pardalotes.

The 'monitoring white gum regeneration' study on Bruny Island, established in 2012 (Strutt and Wright, 2014), is related to the forty-spotted pardalote research above. The study aims to investigate management strategies to stimulate regeneration in fragmented woodland remnants and around isolated paddock trees. Management strategies considered include grazing exclusion and competition manipulation via: scalping (removing the top layer of soil and plant roots); burning; and herbicide spray (with and without wetting agent). The Threatened Plants of Tasmania group assisted with re-surveys in May 2016. The results demonstrate 138 eucalypt seedlings of which 95 where white gums, similar to 2015. Grazing exclusion continues to help eucalypt germination with fencing 10m from the canopy of isolated paddock trees resulting in best seedling recruitment. There is no difference between excluding stock alone, and excluding stock and native browsers. Treatments such as scalping and burning, and adding swales downslope from isolated paddock trees appear to promote regeneration (Strutt and Wright, 2014). This study has implications for habitat regeneration, but is more applicable to agricultural, rather than forestry, areas.

3.3. Other miscellaneous projects relating to Tasmanian forests

A range of other projects is 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.

General

- A PhD project by Scott Whitemore at the ARC Centre for Forest Value, University of Tasmania, supported by the FPA, FT, TLC and others, will look at the potential of acoustic recordings to replace field-based surveys to determine site occupancy of threatened bird species.
- An acoustic recording device and associated processing software were trialled to detect the yellow wattlebird (*Anthochaera paradoxa*). Positive results indicated the technology would be an efficient tool for invasive species surveillance (Dewar 2015)
- A study on fire and grazing in sedgeland, heathy forest and grassland found heathy forest and sedgeland responded primarily to fire rather than grazing with heathy forest returning to a new state with burning (Kirkpatrick et al. 2016)
- A survey (using hair traps) of the mammalian community across the spatial extent of the Tasmanian devil’s progressive population decline (lowest in west, highest in the east) of northern Tasmania found a shift towards an alien invasive species state linked with devil decline (Hollings et al. 2016a)
- The common brushtail possum (*Trichosurus vulpecula*), a prey species of the Tasmanian devil, was found to spend more time on the ground foraging, find food patches faster, and forage more with increasing years since the Tasmanian devil decline and disease outbreak began (Hollings et al. 2016b). Results were indistinguishable compared to a devil-free island.
- Remote cameras were used to analyse effects on small mammals of climate, conspecifics and predators: swamp rats had a negative effect on black rats; black rats and feral cats had a negative effect on long-tailed mice (Lazenby et al. 2015)
- A comprehensive description of habitat of the newly described *Antechinus vancycki* with the conclusions that more research into the distribution and ecology of the species is required for management and conservation (Neyland 2015).
- Tracking Tasmanian devils after translocation to Maria Island found after 122 days of relocation 93% of devils had survived and wet eucalypt forest was avoided as a habitat preference in favour of agriculture and urban habitats (Thalmann et al. 2016).
- A pathway to population recovery was outlined with baseline data for the critically endangered King Island Scrubtit (*Acanthornis magnus greenianus*). The study established occupancy and detectability data, with the former at <1km and declining (Webb et al 2016).

Forest management

- An Honours project in the School of Biological Sciences at UTas aims to develop a simple and easy to use index of forest maturity based on measured biological and structural variables in Tasmanian wet eucalypt forests (Laura van Galen unpublished data UTas).
- In a review of studies which look at soil organic carbon, Dean et al. (2016) comment that studies which show that conventional harvests do not deplete soil organic carbon in the mineral soil have been a function of the short time frames of these studies.
- Aggregated retention methods were comparable to clear-fell burn and sow methods, with no significant differences between methods for early regeneration densities, edge effects and growth rates (Scott et al. 2015).
- *Pinus radiata* needle fungal communities differed greatly, depending upon the total annual rainfall and needle age. Needles were investigated in association with environment as a link to factors associated with spring needle cast (Prihatini et al. 2015, 2016)
- An empirical model of annual water use by *Eucalyptus nitens* plantations based on basal area explained 78.5% of the variability in water use with the inclusion of annual rainfall data. The basal area: water-use relationship was included in Forestry Tasmania's forest estate model (Roberts et al. 2016)
- The similarities and differences in continuous cover silvicultural methods of Bavarian and Tasmanian forest systems were contrasted in terms of practice, history, ecology, and social acceptability (Hickey et al. 2015)
- *Eucalyptus* spp in dry eucalypt forests were found to be more tolerant to fire (high-severity fire) than obligate seeder wet eucalypt forests, however, fire frequency may increase vulnerability to increasingly frequent severe fires in dry forests (Prior et al. 2016)

Climate change

- Mean soil methane uptake increased with a maturity gradient along a chronosequence of sites regenerating from wildfire, with oldest stands observing a decrease in soil methane. These differences were largely driven by differences in soil moisture status. With climate change, an increase in wildfire could potentially increase overall forest soil methane sinks (Fest et al. 2015)
- Authors found no relationship between organic nitrogen and carbon content, and could not validate the use of organic soil nitrogen and carbon content for inferring vegetation type/change in fire determined forest/non-forest of western Tasmania (Fletcher et al. 2015).
- The role of the Southern Annual Mode (SAM) in fire regimes was explored for southern Tasmania by Mariani and Fletcher (2016). Synthesis of charcoal records spanning the last 1000 years found fire activity and SAM were tightly linked with a spike in 21^{st} century fire activity driven by human-induced climate change.

- Various scenarios of forest ecosystem change were explored in a qualitative modelling approach by Herr et al. (2016) for the forest ecosystems found in the Warra LTER. The approach reduced model uncertainty and focused research priorities, which included pathogens, fire and climate.
- Forest fire danger index was found not be a good indicator of fire danger in Tasmanian rainforest, but that 50 mm of rain in the month previous to a fire was a good predictor, emphasising the need to respond to dry conditions for fire management (Styger et al 2015).
- Rainforest throughfall (the amount of rain that reaches the forest floor) was found to vary significantly and spatial pattern was not predicted by canopy cover or other structural variables. High spatial variability indicates forest floor moisture conditions may not be a good indicator for potential fire danger (Styger et al 2016).

4. Discussion and 2016–17 priorities

The outcomes of the FPA supported studies covered in this 2015 –16 report contribute to our understanding of the effectiveness of the general biodiversity code provisions (priority projects 2, 5, 6 and 8, Box 1) and the threatened fauna management provisions (priority projects, 1,2,4 and 5, Box 1).

The write up of some long-term projects began this year. A study started in 1998 found that, in general, the small patches of trees retained in partial harvested coupes (wildlife habitat clumps), to aid recolonisation of hollow-using fauna survived and provided habitat for the 17 year period of the study. Another study found that current stream management practices may be appropriate to maintain a population of platypus in the long term in a catchment disturbed by forestry activities. Such long-term studies should be encouraged as short-term studies may not always provide the complete picture.

The difficulties of gathering meaningful data to test the management approach for some threatened species are demonstrated by two studies, on the giant freshwater crayfish and the wedge-tailed eagle. However, work continues in this area and some promising results have been obtained through the use of remote cameras to assess the adequacy of plantation management approaches in maintaining populations of medium-sized mammals, including the threatened Tasmanian devils and spotted-tailed quolls. Further surveys are required, but preliminary results indicate that the approach taken since 2000 for the keeled snail may have contributed to maintenance of this species in harvested areas. Projects that aim to test, refine or develop threatened species habitat models continued this year to further facilitate landscape-scale management of biodiversity values.

The importance of doing baseline ecological research as well as effectiveness monitoring was highlighted again this year, with ANU researchers finding that parasites and competition for tree hollows impacted on the breeding success of threatened birds. Threats to native species are not always obvious and may interact with forestry impacts in complex ways.

A range of other projects contributed to our collective understanding of the ecology of our forests and their biota. Of particular interest are a number of studies exploring alternative ways to monitor species (e.g. remote cameras and acoustic recording methods) and answer ecological questions. Such indirect methods will provide a cost-effective way of gathering data to evaluate the effectiveness of management approaches into the future.

The monitoring program for 2016–17 will continue to focus on the priority project areas in Box 1. In addition, on completion of the Threatened Plant Adviser, priorities for the monitoring of management actions for threatened plants will be determined following a similar process to that taken in Forest Practices Authority, 2012a.

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