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

2021–22 summary report

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Report to the Board of the Forest Practices Authority

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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. It should also be noted that some of the results presented in this report are only preliminary.

Front page photographs:

- Left: Jo Potter-Craven (NRE Tas) and David Hogan (Sustainable Timber Tasmania) using an endoscope camera to survey inside a trapdoor spider burrow (Photo: A. Gardner)
- Top right: Trapdoor spider species inside a burrow (Photo: J. Potter-Craven)
- Bottom right: External view of a trapdoor spider burrow (Photo: J. Potter-Craven).

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 and papers 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 provided us with brief summaries of their work and have allowed us to include the results from their research undertaken independent of the Forest Practices Authority. Such research provides information that can be used to assess the effectiveness of the *Forest Practices Code* provisions.

Thanks to the Board of the Forest Practices Authority for agreeing to continue to fund the biodiversity effectiveness monitoring plan. Thanks to Chris Grove for feedback on the draft report.

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.
- This report summarises projects by FPA staff and students, carried out during the 2021–22 financial year, as well a brief summary of projects done by other researchers (independent of the FPA), where the results contribute to our understanding of the effectiveness of the Tasmanian forest practices system.
- Three FPA-affiliated projects current in 2021–22 contribute to our understanding of the effectiveness of the *Forest Practices Code* provisions for biodiversity in general. One project is considering how the forest practices system should adapt to climate change, one is looking at how post-disturbance harvesting should be done, and one is looking at the impact of harvesting on *Dicksonia antarctica* in a partial harvest system.
- There were 17 FPA-affiliated projects current in 2021–22 that contributed to our understanding of the effectiveness of *Forest Practices Code* provisions for threatened species. Many of these projects are highly intensive tracking or trapping projects to understand how fauna respond to harvesting (eagles, Lake Fenton trapdoor spider), how they use human-modified landscapes (masked owls, devils, green and gold frogs) or what their habitat requirements are (grey goshawks). There were also three new projects looking at the implementation of management recommendations, which is a key component to understanding if management is effective.
- Research not affiliated with the FPA continues to inform management and monitoring practices. Of particular note this year is research by UTAS asking the question is ‘land sparing’ (i.e. reservation) or ‘land sharing’ (i.e. multiple use land management) more effective for maintaining the dual objectives of timber production and biodiversity management.
- The results of research are used to improve management. Over the last year management recommendations have been developed for newly listed species, and changes to the management of swift parrots has been triggered by new ecological information.

1. Introduction

The Tasmanian forest practices system follows an adaptive management framework which includes an emphasis on research, review and continuing improvement. It is widely recognised that ongoing research and monitoring is important for the scientific credibility of the *Forest Practices Code'*s provisions applied in forest management plans (Commonwealth of Australia & State of Tasmania, 1997; Davies et al., 1999; Wilkinson, 1999). There is also a legislative requirement to monitor the effectiveness of *Forest Practices Code* provisions applied in forest practices plans. 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 Natural Resources 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 *Forest Practices Code* provisions needs to be clear.

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 and taking into account social, economic and environmental outcomes…*'. A General principle for the management of biodiversity is '*Forest practices will be conducted 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 2020). The *Forest Practices Code* 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 outlined in (Munks et al., 2020). These have been developed from a mixture of expert judgement, practical experience and the outcomes of research and monitoring.

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, 2013). 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 Species Adviser. See Box A and Box B for the highest priorities for Code provisions and threatened fauna provisions respectively (FPA, 2013). Priorities for threatened flora species were identified in 2018–19 as part of the development

of management recommendations for the Threatened Plant Adviser, and a report is now available (Koch et al., 2022) (Box C).

Box A. The priorities identified for monitoring the effectiveness of the general biodiversity-related *Forest Practices Code* provisions (FPA, 2013), in bold if progressed in 2021–22.

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 hygiene measures help prevent 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 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**

Box B. The priorities identified for monitoring effectiveness of threatened fauna management provisions (FPA, 2013), with projects progressed in 2021–22 indicated in bold.

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

Work is done each year by FPA staff 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 findings from projects current during the 2021–22 financial year. It includes projects undertaken by FPA staff (mostly in collaboration with other research providers) and those done by other researchers (independent of the

FPA) where the results contribute to our understanding of the effectiveness of actions taken for biodiversity values through the forest practices system.

Box C. Draft priorities identified for monitoring the effectiveness of threatened flora management provisions (Koch et al. 2022). In bold if research was done during 2021–22.

General

1. Effectiveness of *Phytophthora cinnamomi* management.
2. Effectiveness of surveys for identifying threatened plants.
3. The occurrence of threatened plants in plantations.
4. Effectiveness of the current management approach for three sites of potential significance for flora (rocky outcrops, swamps and inland *Eucalyptus amygdalina* forest).

Species specific

Rank	Species	Rank	Species
1	*Hibbertia calycina*	3	*Boronia hemichiton*
1	*Epacris moscaliana*	3	*Hibbertia rufa*
1	***Cyathea cunninghamii***	3	*Conospermum hookeri*
1	*Thynninorchis nothofagicola*	3	*Spyridium lawrencei*
		3	*Epacris virgata Beaconsfield*
2	*Blechnum spinulosum*	3	*Caladenia pallida*
2	*Euphrasia collina* subsp. *deflexifolia*	3	*Caladenia tonellii*
2	*Euphrasia collina* subsp. *gunnii*	3	*Epacris curtisiae*
2	*Euphrasia scabra*	3	*Epacris limbata*
2	*Euphrasia semipicta*	3	*Thelymitra jonesii*
2	*Isolepis habra*	3	*Pultenaea mollis*
2	*Pomaderris phylicifolia* subsp. *ericoides*	3	*Xanthorrhoea bracteata*
2	*Pomaderris phylicifolia* subsp. *phylicifolia*	3	*Epacris exserta*
2	*Sowerbaea juncea*	3	*Epacris apsleyensis*
2	*Thelymitra holmesii*	3	*Austrocynoglossum latifolium*
2	*Rhodanthe anthemoides*	3	*Bertya tasmanica* subsp. *tasmanica*
		3	*Eucalyptus perriniana*
		3	*Pomaderris pilifera* subsp. *talpicutica*
		3	*Prasophyllum crebriflorum*
		3	*Prasophyllum robustum*
		3	*Prasophyllum stellatum*
		3	*Pterostylis falcata*
		3	*Pterostylis grandiflora*
		3	*Cyathea x marcescens*
		3	*Hypolepis distans*

2. Summary report on FPA research and effectiveness monitoring covered in 2021–22

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

2.1. General *Forest Practices Code* provisions for biodiversity

The following sub-sections provide a brief summary of the projects current in 2021–22 which contribute to our understanding of the effectiveness of actions and inform continual improvement of *Forest Practices Code* provisions.

2.1.1. Climate change

Tasmania is experiencing a changing climate. The FPA have initiated a project to identify the ways in which production forests may be impacted, and potential ways the forest practices system could adapt in response.

The first step of the project was to seek expert feedback on the potential impacts of climate change on Tasmanian production forests, and ways that land managers could adapt in response. The report produced from this expert feedback is available on the FPA website (Koch 2022).

The second step of the project was to host a stakeholder workshop, to discuss which of the potential actions might be pursued, and how they could be implemented. This workshop was held in September 2022.

The final step of this project is to use the information gathered from steps 1 and 2, and draft a report to the Board of the FPA suggesting actions that FPA and the industry could take to adapt to climate change. This report will be finalised in 2023.

2.1.2. Post-disturbance harvest

Natural disturbances, such as wildfire, are likely to become more prevalent under a changing climate. The Code currently provides little guidance on if or how harvest operations should be done following disturbance events. To help the FPA make decisions on the whether to approve future harvest operations after disturbances, a literature review of 'post-disturbance' harvesting research has been conducted. In addition, forestry practitioners from NSW and Victoria were interviewed to determine the practices they have in place and how they developed these management recommendations. This information is being used to draft a decision-making framework for Tasmania which will go through a process of stakeholder consultation. A monitoring program will be designed in conjunction to help assess the effectiveness of the adjusted management recommendations.

2.1.3. Impact of harvesting on *Dicksonia antarctica*

Dicksonia antarctica is a conspicuous and long -lived understorey species of the cool wet forests of south-eastern Australia. This species plays an important ecological role, via the

provision of substrate for rainforest tree and shrub germination and as a support for the obligate and facultative epiphytic flora. Tree ferns are available for harvest in Tasmanian under the Tree Fern Management Plan.

Long term monitoring of* Dicksonia antarctica *after cable logging

In 1992 the FPA initiated a long-term study of the impact of harvesting and regeneration burning on *Dicksonia antartica* using permanently tagged individuals in a treatment and control area. Dr Peacock and the FPA have continuously monitored the study for thirty years, making it one of the longest plant population studies nationally. The population was cable logged and subject to regeneration burning with 80% of *D. antarctica* individuals resprouting following the physical damage associated with cable logging. Only 40% of tree ferns survived the additional imposition of intensive burning. Growth suppression beneath the dense forest cover, competition for light and browsing pressure further reduced survival to 27% after 30 years. No mortality was observed in undisturbed controls although a small proportion of monitored individuals were damaged by natural branch falls and a wildfire. Limited recruitment and persistence occurred during the study period with various recruitment cohorts being lost to drought and shading. The results indicate that multiple disturbances associated with intensive forest management practices in wet forests are detrimental to the long-term growth of the species within the harvest footprint.

FPA assisted project manager Ross Peacock collect the data for this project in January 2022.

Exploring the retention and recruitment of* Dicksonia antarctica *under partial harvest

The Tree Fern Management Plan 2022 states that tree ferns can be harvested from partially harvested coupes as long as certain principles are met. These principles include that tree ferns would otherwise have been destroyed by the harvesting activities, and tree ferns will regenerate adequately on the site. To date, tree ferns have largely been harvested from clearfall coupes where it is more obvious that the tree ferns would be destroyed. However, some forms of partial harvest have a considerable impact on tree fern survival. Therefore a study was initiated to determine if tree fern survival differs between partial harvest coupes subject to tree fern harvesting, and those without tree fern harvesting. The project will also consider the effectiveness of retained areas for maintaining tree ferns in the landscape and, over time, should provide data on recruitment of tree ferns under partial harvest regimes.

A pilot study for this project has commenced and, if successful, the full study will be initiated.

2.2. Threatened species management

The following summaries are for projects current in the 2021–22 financial year that looked at the effectiveness of provisions for threatened fauna and flora species. They contribute to priority area A4 (Box A), threatened fauna project areas B1, 3, 5, 6, 7, 8 (Box B) and one threatened flora project (Box C).

2.2.1. Wedge-tailed eagles

The Tasmanian wedge-tailed eagle (*Aquila audax fleayi*) is listed as endangered at both a state and federal level. It is currently recognised as an endemic sub-species although a genetics study raised questions about this taxonomic status (Burridge et al., 2013). Management of this species under the forest practices system focuses around the nest site. Given the large number of wedge-tailed eagle nests recorded in Tasmania, there is considerable interest from industry to ensure effective and efficient management. During 2021–22 FPA staff were involved, to varying degrees, in four projects which contribute to our understanding of the effectiveness of management actions for this species.

FPA annual nest monitoring

The FPA Eagle Research and Monitoring Program was initiated in 2007 with the aim of monitoring the rate of nest success and the timing of breeding season events. This work was revised during 2015 to limit surveys establishing the timing of the breeding season.

During the 2021–2022 breeding season annual nest monitoring surveys were completed in October 2021. The total number of nests flown was 305, of which 76 were identified as active (with nests containing either a young chick, egg or adult in an assumed incubation pose). A second round of flights was done in November 2021. Of the 19 nests where a chick could be aged, the last bird from the sample was expected to fledge on the 8/2/22 if using a 12 week hatchling phase. Given the hatchling phase is often longer the season was extended to the 13 February.

Strategic eagle nest management

In 2016 FPA initiated a project to develop a strategic approach to managing eagle nests in production forests. This study used expert assessments to try and develop a method for identifying unused or non-priority nests. Initially experts did the assessments independently, but there was poor correspondence between experts in identifying non-priority nests, in the attributes used to identify non-priority nests and in how the attributes were assessed. The assessments were repeated collectively, with very high conformance. Differences in screen size, resolution and willingness to not make an assessment may have contributed to the difference between individual and collective assessments.

Nests that are not actively maintained, and therefore unlikely to be used by eagles, will degrade over time. The ongoing status of nests classified as ‘degrading’ during aerial assessments between 2012 and 2020 (excluding 2017) were examined. The accuracy of these aerial assessments is uncertain, so results should be interpreted with caution, but the rate of re-use for nests assessed as degrading appears to be low.

The results of this project have been written into a draft report. A workshop is planned to discuss the report and any implications for eagle management in late 2022.

Testing the effectiveness of select actions to mitigate the impact of disturbance on the Tasmanian wedge-tailed eagle

FPA is collaborating with UTAS researcher Dr James Pay, to determine whether the 500m/1km line-of-sight recommendation is effective in mitigating the impact of disturbance to breeding eagles. This is being done by attaching transmitters to adult birds, monitoring their activity and how it changes in response to forestry activities occurring in a nearby coupe.

In early 2021 transmitters were attached to seven 'industry' birds. Of these, two birds bred at the target nest allowing industry data to be collected. Six more transmitters were deployed in 2022, of which again only two bred in the target nest. The data from the birds and the harvest operation will be used to assess the types of activities, and distances from the nest at which breeding eagles are disturbed.

This project is being done in collaboration with UTAS and is funded through a FWPA grant received by the FPA in 2018 with funding support from, Forico, Timberlands, Sustainable Forest Management, Sustainable Timbers Tasmania and Norske-skog.

Eagle Eye - Applying the Internet of Things to landscape scale wedge-tailed eagle management

This Sustainable Timber Tasmania (STT) led project tested the application of an Internet of Things (IoT) approach to monitoring wedge-tailed eagle nest activity as a potential alternative to the current air and ground-based nest activity checking practices carried out for industry. This project was finalised in the 2021–22 financial year. The Executive Summary from the final report is provided below.

"This project examined the application of the Internet of Things (IoT) to the management of the endangered Tasmanian wedge tailed eagle (WTE) in a landscape shared with industrial forestry operations and electricity transmission infrastructure. Broadly, the IoT utilises sensors, communications networks and human interface systems to support efficient decision making.

"An IoT approach to monitoring WTE nest activity has the potential to increase economic activity and animal welfare outcomes whilst reducing the worker safety concerns and costs that are associated with the current helicopter-based nest activity checking practices. To facilitate this, two different types of sensors, Passive Infrared (PIR) and Ultrasonic (US), were tested to identify which was the most effective, efficient, reliable and robust to detect nesting activity by WTEs. Data from these sensors was collected via a network of wireless Gateways (or Portals) using industry standard LoRa protocols, processed and stored in a cloud-based repository then reported through a web-browser based dashboard and corporate information systems (Microsoft's Power BI).

"Success in this project would lead to information collected by an IoT solution that would enable forest and electricity network managers to make more timely and objectively informed management decisions around operations that may interact with WTEs, with improved productivity, reduced costs, increased safety and positive animal welfare outcomes, compared to the current regime.

"The project identified that the PIR sensor provided the most informative data for WTE management and was successfully supported by the LoRa network deployed throughout the study landscape, and the web-browser based data dashboard, that could be accessed from anywhere with an internet connection to provide the information to support decision making. However, before operational deployment of this technology is considered, three issues need to be addressed. Firstly, the PIR sensor used was not completely reliable in its operation. However, it is expected that this can be addressed through refinement of the hardware and firmware. Secondly, the current satellite communications technology used to support LoRa networks lacks the required reliability and serviceability, so this limits the deployment of LoRa to those areas with mobile phone network coverage, where the technology was more reliable and effective. It is expected that in the near future, the satellite technology will improve in reliability, serviceability and costs, taking away the geographic constraint to deploying LoRa. Finally, the relevant regulators need to be satisfied that the installation and presence of the equipment has negligible impact on WTE breeding success. Whilst the initial findings in this project indicate negligible impact, further data collection on nest activity from nest trees with and without sensors will be needed to confidently determine if this is indeed the case. An economic analysis comparing the costs of the current airborne nest activity checking to an Eagle Eye IoT approach to nest activity monitoring indicated a strong financial case in favour of the Eagle Eye IoT approach".

2.2.2. Masked owls

The Tasmanian masked owl (*Tyto novaehollandiae castanops*) is an endemic subspecies that is listed as vulnerable under the EPBC Act and endangered under the Tasmanian *Threatened Species Protection Act 1995.* The Threatened Fauna Adviser recommends retention of mature forest habitat (as a surrogate for nesting habitat) in areas where the bird is likely to occur. In areas where an operation is to occur near a known masked owl nest or roost site, the FPA and DPIPWE might recommend a 100 m radius reserve be retained around such a site.

Tracking masked owls to understand their habitat use

UTAS Honours student Jack Service is tracking masked owls to better understand their habitat requirements. So far transmitters have been attached to four adults, with transmitters taking about six fixes a night for about four weeks. Cameras have been installed at the two nesting hollows found. Information is being sought on basic life history (number of roosts per bird, home range size, hollow and tree attributes), the areas selected for foraging and roosting, and an indication of how selective the birds are in roost sites.

The project is being done under the supervision of Dr James Pay (UTAS), Dr Chris Burridge (UTAS), Dr Amy Koch (FPA) and Jason Wiersma (FPA). The project is funded through a FWPA grant received by the FPA in 2018 with funding support from, Forico, Timberlands, Sustainable Forest Management, Sustainable Timbers Tasmania and Norske-skog.

Figure 1. (a) An owl emerging from a nesting hollow (b) a tree climber installing a camera above the nesting hollow (Photos: J Service).

Implementation monitoring

In order for management actions to be effective, it is important they are implemented correctly. In 2022 a study was initiated to determine if masked owl planning is being done correctly. This will allow the FPA Biodiversity Program to determine if improvements could be made to the planning tools, management recommendations outlined in the Threatened Fauna Adviser, or training provided to the FPOs.

FPPs and associated information were examined for 11 private coupes (dry forest) and 18 coupes on public land (10 in dry forest and 8 in wet forest). The use of planning tools, decisions reached and management recommendations identified were examined. Overall a high level of planning was achieved. Where mistakes were made it appeared to often be due to issues with the planning tools or terminology used. FPOs working on public land tended to make fewer errors than FPOs on private land, but this is unlikely to be a result of differences in planner skill. This review, while based on a small sample size, provided useful insight into some of the issues with planning habitat management for masked owls using the current planning tools and management recommendations. This project will be written into a report and used to review masked owl management in 2022–23.

2.2.3. Swift parrot

The swift parrot (*Lathamus discolor*) is federally listed as critically endangered and state listed as endangered. This species relies on tree hollows for nesting, and forages primarily on the flowers of *Eucalyptus globulus* and *E. ovata*. Many threats facing this species, including habitat loss and predation by sugar gliders (*Petaurus breviceps*). Management recommendations for this species in areas covered by the forest practices system are provided in the Threatened Species Adviser.

Implementation monitoring

FPA has initiated a project looking at implementation of the swift parrot management recommendations. The study will be a desktop exercise, examining FPPs and other supporting material. Attempts will be made to examine FPPs from different areas within the breeding range, from public and private land, and from wet and dry forest. The results of the project will be written up in 2022–23.

2.2.4. Grey goshawks

In Tasmania grey goshawks (*Accipiter novaehollandiae*) are listed as endangered under the *Tasmanian Threatened Species Protection Act 1995.* Grey goshawks are thought to be threatened by habitat loss, persecution, collision and poison (http://www.threatenedspecieslink.tas.gov.au/grey-goshawk). The grey goshawk is found in eastern and northern Australia and New Guinea, but the white colour morph predominates in Tasmania.

Grey goshawks have been recorded over much of Tasmania, but most sightings are from large areas of wet forest including rainforests. Anecdotal information suggests that forest with a closed canopy and low stem density, below 600 m altitude, is favoured by the birds for nesting during summer months. Goshawks also appear to require forest with an open structure under the canopy for foraging (FPA, 2010). However, very little targeted research has been done on habitat use by grey goshawks in Tasmania.

Tracking goshawks in northern Tasmania – write-up of historic data

In the early 2000s FPA and NRE (formerly DPIPWE) were involved in a radio-tracking study in north-western Tasmania that aimed to gather data on the movements and characteristics of habitat used by grey goshawks. Only a few birds were tracked, but these data are considered an important resource given the paucity of information on this species. The data are in the process of being written up, but there have been delays over the last 12 months meaning the project is currently on hold.

Habitat use by grey goshawks in southern Tasmania

UTAS PhD candidate, Dave Young, started a project in 2021 looking at habitat use by grey goshawks in southern Tasmania. The overall aim of his PhD is to apply an integrated approach at multiple spatial scales to advance our knowledge and understanding of the

spatial and reproductive ecology of the grey goshawk in modified landscapes of south-east Tasmania. This research will investigate the ways in which highly modified anthropogenic habitats promote or negatively impact populations or individuals of this raptor. Dave is using GPS tracking devices to investigate factors that influence adult grey goshawk home range size, ranging behaviour and spatial and temporal patterns of habitat use. Dave is also using data on the large number of nesting sites he has located to investigate nest site selection and characterise nesting habitat in the south-east. A species distribution model is being created to predict the location of nesting habitat. This research will provide much needed information to guide improvements to current conservation management strategies in Tasmania.

Dave is being supervised by the FPA Biodiversity Research Manager and is receiving advice and support from FPA's raptor specialist Jason Wiersma.

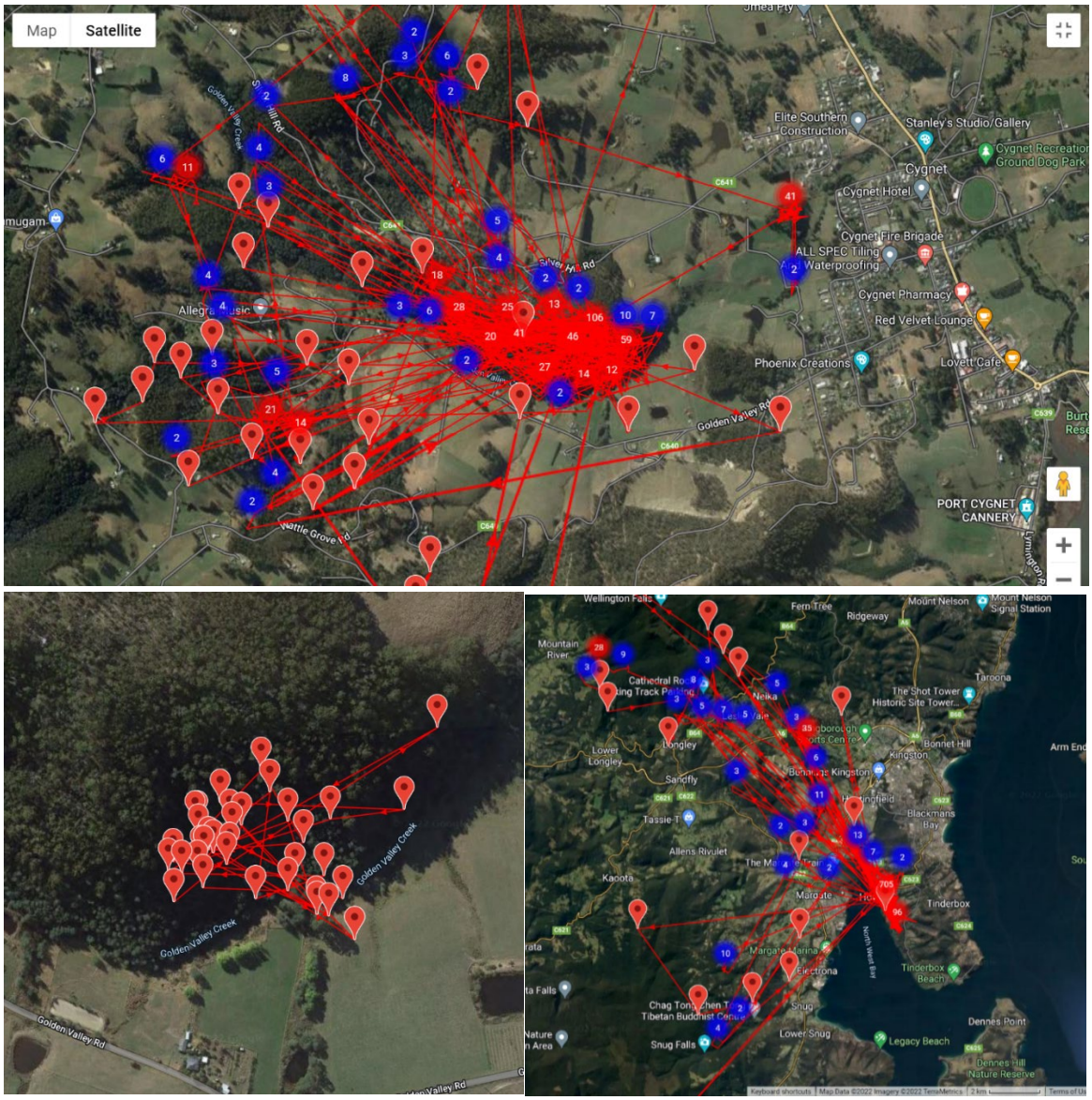


Figure 2. Preliminary tracking data from grey goshawks; (a) female activity approaching the breeding season, (b) breeding female, (c) non-breeding male.

2.2.5. Devils and quolls

Tasmania supports the most diverse guild of marsupial carnivores on the planet, consisting of Tasmanian devils (*Sarcophilus harrisii*), spotted-tailed quolls (*Dasyurus maculatus*) and eastern quolls (*Dasyurus viverrinus*). These carnivores occupy an important role in Tasmanian ecosystems, and all three are federally listed as threatened (devils and spotted-tailed quolls are also listed under state legislation). They are all managed under the forest practices system, and FPA have been involved in one project in the last financial year.

UTAS PhD student Evie Jones and her colleagues are exploring how Tasmanian marsupial carnivores respond to forestry landscapes and operations, to identify ways that production forests could be managed to enhance their conservation.

In 2020–2021 Evie used a network of remote cameras across three production forest landscapes to determine the distribution and abundance of devils and eastern quolls. Early results indicate a positive association between both species and plantation extent, suggesting plantations provide valuable habitat for these carnivores. There was also a positive association between devils and higher tree density, and between quolls and indicators of open habitat such as grassland, fewer/smaller trees and less understorey. In plantations windrows seem to be important for devils and quolls, with a positive association between both species and larger windrows (in pine plantations only for quolls), and between eastern quolls and windrows comprised of eucalypt plantation slash. Neither species responded to logging features in harvested native forest (e.g. time since logging, logged forest vs unlogged remnants), suggesting they may be adaptable to these modified landscapes.

In 2021 Evie monitored 15 devils with GPS radio-collars in a plantation landscape to examine their home ranges, habitat selection and den use. Data are currently being analysed. Five den sites were located, including one maternal den in a wombat burrow in a plantation windrow. The non-maternal dens were located in windrows (2) and native forest remnants (2), and all but one were in wombat burrows.

Analysis of biological sampling of devils and quolls taken monthly during the GPS tracking period will measure their health in plantations. Additionally, blood samples were collected from devils pre- and post-culling of browsers in a plantation to investigate if devils show elevated blood lead levels from scavenging shot carcasses. Hair samples were also collected to look for any potential long-term lead contamination.

2.2.6. Tasman Peninsula dusky antechinus

UTAS Honours candidate Rachel Mirk was planning to do research looking at the distribution and habitat requirements of the threatened Tasman Peninsula dusky antechinus (*Antechinus vandycki*). This species was only recognised in 2015 and so little is known about its ecological requirements. However despite intensive efforts Rachel did not manage to

trap any antechinus, so she changed the focus of her thesis to compare the effectiveness of different techniques for trapping/monitoring small mammals.

This project was supervised by Professor Barry Brook (UTAS), Dr Michael Driessen (NRE) and Dr Amy Koch (FPA).

2.2.7. Green and gold frogs

Litoria raniformis (green and gold or growling grass frog) is the largest endemic frog in Tasmania and is currently classified as threatened at a state and national level. Habitat loss due to land-use change is considered one of the major pressures faced by this species, accelerating its decline in recent decades. A Deakin University PhD project by Tim Garvey investigated the presence and activity of this species in a plantation context compared to an agricultural context. This thesis was accepted in 2021 (Garvey 2021). A summary of the research findings was provided in Koch (2021). This project received some financial and technical support from FPA.

2.2.8. Giant freshwater crayfish

The giant freshwater crayfish (*Astacopsis gouldi*) is listed as vulnerable under both state and federal legislation. In the recovery plan for this species, habitat disturbance by forestry is listed as a threatening process (Commonwealth of Australia, 2017). The Threatened Species Adviser recommends that the giant freshwater crayfish habitat suitability map and field surveys be used to assess habitat quality for this species, and that wider streamside reserves are implemented in areas of higher quality habitat (FPA, 2015).

Headwater stream management for the giant freshwater crayfish

One of the main ways forestry could impact the species is if forestry led to increasing sedimentation levels downstream. While the Threatened Species Adviser recommends wider streamside reserves in areas of higher quality habitat, some members of the public have raised concern that upstream management in areas that do not provide quality habitat (and therefore only standard class 4 stream guidelines are recommended) is inadequate for managing downstream habitat for this species (T. Walsh pers. comm.). Therefore, FPA initiated a study, in collaboration with STT, UTAS and DPIPWE, testing the effectiveness of the class 4 stream guidelines in reducing sediment input to sub-catchments that support the giant freshwater crayfish.

A trial of the revised field methods was conducted in 2021–22 but the project team still has concerns about the practicality of the methods and quality of the data that would be obtained. This project is currently on hold due to other priorities.

Implementation monitoring

A new project is examining a number of FPPs to review how well giant freshwater management recommendations are being implemented. Data collection was completed in 2022. This project will be finished in the 2022–23 financial year.

2.2.9. Simsons stag beetle

Hoplogonus simsoni (Simsons stag beetle) is a threatened species of stag beetle listed as vulnerable on both the Tasmanian *Threatened Species Protection Act* 1995 and Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999. A manuscript is being prepared examining *H. simsoni* count data in one coupe subject to CBS silviculture, and one to thinning in 2002–03. This project has been delayed but is expected to be completed next financial year.

2.2.10. Lake Fenton Trapdoor Spider

The Lake Fenton trapdoor spider (*Plesiothele fentoni*) is currently listed as endangered under the Tasmanian *Threatened Species Protection Act 1995*. There are only a small number of records of this species on the Natural Values Atlas and the species was thought to have a highly restricted distribution. New observations in 2022 led to a confirmed extension of the range of this species. Under the Tasmanian forest practices system, *P. fentoni* is currently managed on a case-by-case basis, with no specific management prescriptions for the species delivered via the Threatened Species Adviser.

Given the lack of ecological information on this species, a study was initiated in 2022 to determine how the presence of trapdoor spiders is impacted by timber harvesting (both clearfall and selective harvesting) and regeneration burns.

A number of coupes have been identified that have potential *P. fentoni* habitat and are scheduled for harvest. These coupes will be surveyed for trapdoor spider burrows prior to harvest. Any burrows found will be surveyed using an endoscopic camera to determine if they contain a trapdoor spider. Positive identification of any spider as *P. fentoni* will be difficult, thus the study will make generalisations about trapdoor spiders in this area. Depending on the density of burrows in the coupe, it is expected that some of the burrows will be in the harvested footprint, and some will be in retained areas. Each burrow will be marked by a small metal nail within 10 cm of the burrow, to facilitate locating the burrows again after harvest. All burrows containing a spider prior to harvest will be resurveyed shortly after harvest, and again after a regeneration burn if one occurs, and again approximately 12 months after harvest.

The information from this research will inform a review of management for *P. fentoni* under the forest practices system. This project is being managed by FPA Ecologist Angela Gardner, in collaboration with Threatened Species Staff from NRE.

2.2.11. Slender tree fern

Cyathea cunninghamii, also known as the slender tree fern, is an endangered species of fern restricted to wet, cool gullies in New Zealand, Tasmania, Victoria, and a single site in Queensland. It is generally assumed that the distribution of *C. cunninghamii* is restricted by temperature and humidity. To explore this assumption, UTAS Honours candidate Hamish

Dore surveyed eight known sites on the east coast of Tasmania. He investigated population size and health, the diversity and composition of epiphytic mosses, liverworts and ferns growing on the trunks of *C. cunninghamii*, and the stability of the microclimate in which the plants are found. Microclimate was recorded between May 26th and August 9th of 2022 using HOBO microclimate data loggers. Epiphyte diversity was assessed by sampling trunks of *C. cunninghamii* at each site and identifying epiphyte species in the lab. Epiphyte data from four of the sites were compared to data from a study in 2002 (Roberts et al., 2005) at the same sites. Epiphyte diversity at each site was also compared to microclimate. Population counts and health assessments were taken at each study site. Population changes and average health were compared to microclimate.

Populations of *C. cunninghamii* are mostly decreasing and recruitment is low. However, some historical surveys have not been comprehensive which makes it difficult to draw strong conclusions. Populations showed a clear preference for climatically buffered and moist environments, although overall health was higher in sites with lower winter minimum temperatures. Epiphyte species richness appears to have reduced over the last 20 years, with epiphyte species richness seemingly linked to maximum and minimum temperature as well as the variation in temperature. Low recruitment and aging populations, as well as an observed sensitivity to changes in microclimate that may be exacerbated by climate change, indicate a species that is under threat which requires careful management.

3. Other Tasmanian project outcomes that contribute to our understanding of the effectiveness of *Forest Practices Code* provisions for biodiversity in 2021–22

These studies have mostly been done independently of the FPA, 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.

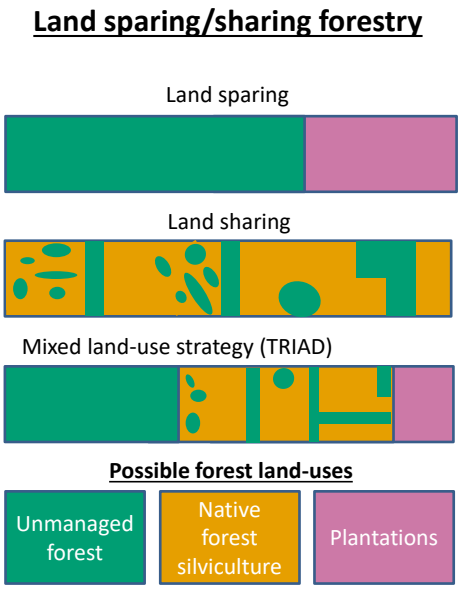
3.1. General *Forest Practices Code* provisions for biodiversity

One of the General principles for biodiversity in the *Code* is '*Forest practices will be conducted 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, 2020). It is therefore important that studies are conducted that assess the impact of forestry on non-threatened values as well as threatened species. Two studies in 2021–22 focused on the relationship between forestry and biodiversity and two broadscale monitoring programs are outlined.

3.1.1. Forest management

Land sparing vs land sharing forestry: determining the optimal mix of forestry systems and reserves to produce timber at least cost to biodiversity

The Forest Sustainability Group at the University of Tasmania are working with industry partners to establish a large-scale landscape ecology trial. The multi-disciplinary research program is based on the premise that the best management for biodiversity at site-scale is not necessarily best at landscape-scale because of trade-offs in meeting timber supply commitments between intensity of management at site-scale and the area available for reserves.



Landscapes can be configured in various ways to produce the same overall amount of timber (see Figure). At one extreme is 'land sparing' where intensive management at site-scale (e.g. short-rotation plantations) allows for a larger overall area dedicated to unmanaged reserves. At the other extreme is 'land sharing' with low-intensity production over a broader area, meaning less land dedicated to reserves (e.g. long rotation aggregated retention in native forests). A range of intermediate strategies are possible, as is the current situation in Tasmania.

This research will involve field-surveys of biodiversity in replicate sites spanning the range of management intensities (pine plantations, eucalypt plantations, native forest clearfelling, aggregated retention, unmanaged) and times since disturbance. The biodiversity data will be integrated with information on timber yield to determine the optimal mix of forestry systems and reserves.

Project objectives:

- to quantify the impacts of forestry systems and wildfire on biodiversity;
- to identify the impacts of forestry on critical species-species and species-environment interactions to recommend monitoring indicators and improved management practices within existing forestry systems;
- to determine the landscape composition of reserves and forestry systems that best support native plant and animal communities for a given yield of timber;
- to optimise the landscape configuration of land-use types for biodiversity and timber production in Tasmania, accounting for the risks associated with predicted increases in wildfire impacts, and practical constraints associated with land tenure.

During 2021–22, the project manager Sue Baker has been progressing the complex process of site selection. Working with STT intern Kira Page, this involved merging GIS datasets from management agencies to combine information including management system, forest age, geology, and recent fire history. This produced a long-list of candidate sites that met project selection criteria. Sue worked with Alison Phillips from STT to start field-based validation of potential sites, focusing on limiting land-use classes of young eucalypt plantation and aggregated retention, but visiting other land-use types in the vicinity. Many sites that appeared suitable on GIS proved unsuitable in the field for one reason or another; and as a result the age-range for the youngest age cohorts was expanded to include 2020-established sites. This work is ongoing.

Covid-related border closures made it hard to recruit PhD students, but a new cohort of international PhDs are now commencing; Janneke Scheeres will be camera trapping mammals, Weiyi Wang conducting bird surveys, and Emanuela Cosma will pitfall trap for beetles. They are still recruiting for a plant ecologist. Sue has also been liaising with international forest ecologists with similar interests, and this resulted in a paper describing how to translate the land sparing vs land sharing paradigm over from agriculture to forestry (Betts et al., 2021).

This project is funded by an ARC Future Fellowship to Sue Baker, an ARC Discovery grant to Sue Baker, Menna Jones, Vanessa Adams and Andrew Balmford, and additional funds provided by Sustainable Timber Tasmania (STT) and the University of Tasmania. In-kind support is being provided by STT, Reliance Forest Fibre, SFM, Forico, FPA and NRE.

Successional responses of soil bacteria and fungi to post-logging burn severity

Ammitzboll et al. (2022) published an article on soil biotic communities. A modified abstract is provided below.

"Globally, forest ecosystems are increasingly impacted by natural and anthropogenic disturbances including fire, timber harvesting and land clearance. Understanding how soil bacteria and fungi are impacted by logging and burning is important for resource management, as these microbiota underpin many essential ecosystem processes such as nutrient cycling and soil formation. Using amplicon sequencing and qPCR of the bacterial 16S rRNA gene and fungal ITS1 region, we quantified the abundance, diversity, and composition of soil bacterial and fungal communities in undisturbed forest and adjacent logged and burnt sites, which included a mosaic of burning severities (unburnt, low severity and high severity burns). Our study was conducted over a 12-month time series post-burn, in the temperate wet eucalypt forests of Tasmania, Australia. We found that over this 12-month period i) after high severity burns, total abundance and diversity returned to pre-disturbance levels in bacterial communities but not in fungal communities and ii) for each disturbance severity, the composition of bacterial communities became more similar to the undisturbed reference communities over time, while fungal communities did not. We also characterised the succession of disturbance responsive taxa in logged and burnt communities, with the relative dominance of copiotrophic bacteria and fire-associated Ascomycota fungi shifting towards oligotrophic bacteria and fire-associated Basidiomycota fungi by 12-months. Further, we highlight specific taxa that respond positively or negatively to the impacts of fire disturbance and discuss the ecological implications of our findings for forest management" (Ammitzboll et al. 2022).

3.1.2. Baseline monitoring

Baseline monitoring is a vital component of a comprehensive monitoring system, as it facilitates detection of broad trends in populations that may be occurring due to land management decisions, or other factors.

Monitoring priority wildlife in the TWWHA: Central Plateau

An array of camera traps was established on the Central Plateau to assess the distribution and activity of priority wildlife and the effect of the 2016 and 2019 bushfires on mammal community activity. Seventy cameras were deployed in forest and highland vegetation and 23 mammal species were recorded. The study found that Tasmanian devils, spotted-tailed quolls, eastern quolls, common wombats (and other non-priority species) are widespread in the area and appear to have recovered or are recovering from the bushfires. The study also noted that feral cats are widespread and Fallow deer were detected as far west as Lake Augusta. This study established a baseline for future monitoring (NRE 2022).

CallTrackers - monitoring Tasmania's bats, Australasian bitterns, and other calling animals

The CallTrackers project (naturetrackers.com.au/projects/calltrackers), designed to monitor for state-level population changes in calling species, involves annual deployment of wildlife acoustic recorders across the same survey squares as WWW (see 3.2.1). Following a successful pilot project for CallTrackers in 2021, a state-wide version was launched in September 2022, with a view to repeating this same effort during September–April annually. Volunteers choose a square that has not yet been surveyed, and a survey date when a recorder is free. On the date, they collect a recorder from the nearest state library and set it up for 8 days in the survey square. Afterwards, they load up the resulting recordings and receive feedback on species identified through automatic call recognisers. Bookings, upload and feedback are all managed by the British Trust for Ornithology's Acoustic Pipeline software. Automatic species identification is at a very basic level at this stage, but as recognisers are increasingly developed — starting with Tasmania's bat species and the Australasian bittern — volunteers will receive feedback both immediately and subsequently on species identified in their recordings. Species location records will also be stored on the Natural Values Atlas.

3.2. Threatened species provisions

3.2.1. Wedge-tailed eagles

Where? Where? Wedgie! State-wide population monitoring of Tasmanian wedge-tailed eagle, and more

Where? Where? Wedgie! (WWW) was launched in 2018, to monitor state-wide population trends in Tasmanian wedge-tailed eagles and other raptors. Volunteers survey annually for presence/absence of all Tasmanian raptor species as well as 'white cockatoos' (sulphur-crested cockatoos, and little and long-billed corellas). The dedicated website coordinates effort in regularly spaced survey squares across Tasmania, and provides training in the survey method and raptor identification. Additional training and promotion are achieved through media, school visits, online lessons, and community talks. Findings from the 2018 pilot indicated that participation inspires conservation action, and guided methodological refinements to improve geographic coverage. The refined method has been carried out every May since 2019, by at least 100 teams each year (110 teams in 2022).

If participation rates remain steady, the WWW data will be more than sufficient to detect state-level population trends over the 10+ years typically required by standard threatened status assessments. However, early warning of any serious decline is clearly preferable, and stakeholders value regular feedback. Power analyses show that, with annual two-day surveys of 100 squares, the program could confidently detect a wedge-tailed eagle population change from one year to the next if it was dramatic (over 30%). The subtler the change, the more years it would take to detect; however, the more squares and days surveyed, the more swiftly such changes will be detected. In particular, the project would require significantly more years and higher participation rates to detect any local population

changes. Overall, state-level population trends will most swiftly be detected with confidence for the most frequently observed species: wedge-tailed eagles, sea eagles (*Haliaeetus leucogaster*), brown falcons (*Falco berigora*) and sulphur-crested cockatoos (*Cacatua galerita*).

Analyses to provide population abundance indices for 2021 and 2022 (the third and fourth years of consistent monitoring) were delayed, but will be reported shortly (see https://webapp.naturetrackers.com.au/map_results). Currently, 80–90 squares are being surveyed for at least two days annually. Coverage across Tasmania is quite good, but promotion to inspire more survey effort in the western half, on private land and on the Bass Strait islands would be preferable to ensure optimally representative results.

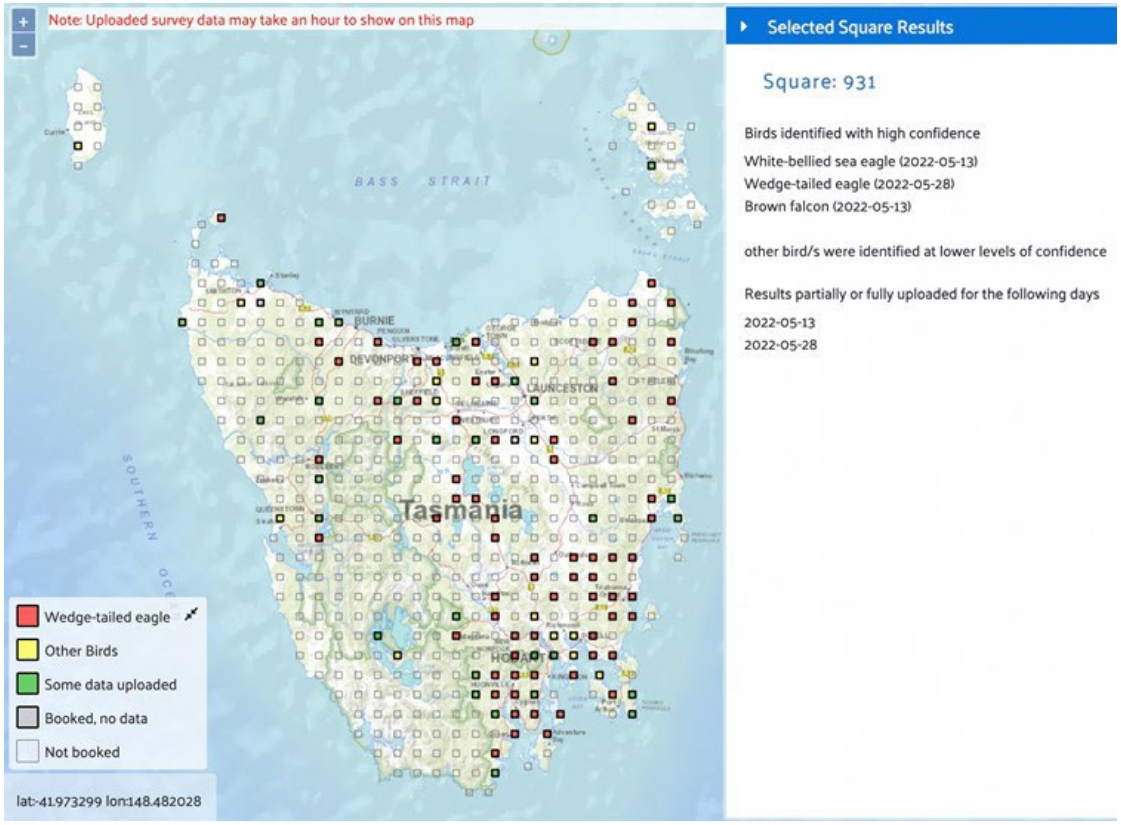


Figure 3. Results map for WWW22, including detail for a specific survey square.

A successful recent application for ARC Linkage funding by the University of Tasmania includes support for a PhD candidate to review alternative analytical methods in obtaining the most accurate estimates of population trends from WWW data, refine the survey method, and translate WWW data into absolute population size estimates with the aid of data from GPS-tagged birds.

3.2.2. Swift parrots

Under the forest practices system all forest operations within the swift parrot breeding range are subject to habitat surveys and assessments. As swift parrots are so wide-ranging, conservation efforts are prioritised to areas with the highest likelihood to support swift

parrot breeding, namely the core range and swift parrot important breeding areas (SPIBAs). Here, all high and medium, and the majority (90%) of low, density potential breeding habitat (nesting and foraging) is excluded from harvesting. Outside the core range and SPIBAs, a mix of these habitat retention measures is applied depending on regional context.

Field and acoustic monitoring of swift parrots on PTPZ Land

In Spring 2021 much of the swift parrot population bred in the Southern Forests, of which a large proportion of this area is Permanent Timber Production Zone Land (PTPZL). STT conducted swift parrot surveys at nearly 400 monitoring sites from October 2021 to February 2022, extending as far south as Recherche Bay and north to the Lonnavale Forests (Barnback, Denison and Russell forest blocks) near the Russell River. Field surveys were done by STT field staff and a consultant ornithologist, and acoustic recorders were also deployed at 36 sites. Half of the sites monitored were in the Lonnavale Forests, an area outside the swift parrot core or SPIBA range but an area used by the species in the 2021–22 season.

The objectives of the monitoring were as follows.

1. Identify and better understand where and how swift parrots are using breeding habitat on PTPZL throughout the breeding season.
2. Identify additional areas of high-quality breeding habitat (not yet reserved or retained) that are important for breeding (being used this season or having good potential for use).
3. Conduct detailed surveys in specific coupes in response to nearby swift parrot sightings.
4. Examine whether STT's habitat retention strategies are effective in supporting swift parrot breeding.
5. Trial the use of acoustic recorders as a potentially efficient monitoring tool to detect swift parrot breeding.

The field and acoustic surveys noted that the birds are social and vocal at the start of the season while looking for suitable hollows and mating, then largely quiet and cryptic during the egg incubation phase, before regrouping into flocks after the young had fledged.

Although from only one season's data, preliminary results suggest the following.

- Swift parrots were breeding on PTPZ land within the Southern forest for the 2021–22 season. Breeding aggregations were observed in the Kermandie Divide, Franklin forest, Tylers Hill and on the Barnback Range. This included observing fledglings, indicating that breeding events were in some cases successful and that these areas have value for swift breeding despite predation from sugar gliders.

- Not all detections early in the breeding season mean that birds remain and breed at that location throughout the season.
- Swift parrots used, and in some cases successfully bred (as evidenced by fledglings) in habitat retained as part of forest practices or some other broader land management strategy such as PTPZL swift parrot reserves or special management zones.
- Burnt forest areas, such as those heavily impacted by the 2019 Riveaux Rd fire, still represent important breeding habitat for the swift parrot.
- Swift parrots were using areas within the Lonnavale forest that are presently not within a SPIBA area.

STT are planning to continue monitoring swift parrots in the 2022–23 season, where the data will provide important information on the long-term occupancy of breeding sites on PTPZL and the effectiveness of management. It is expected that monitoring priorities may vary each year depending on where swift parrots are likely to breed, the nature of any pressing matters, and the questions that are key to inform management decisions.

Figure 4. Image of a swift parrot near a nesting hollow (Photo: M Yee).

Trial of strategies to improve sugar glider trapability for swift parrot conservation

Since 2020 NRM South have been managing a project to develop and trial solutions to improve swift parrot breeding success by reducing predation pressure from sugar gliders. A

secondary aim of the project is to secure conservation covenants with private landholders to protect high value swift parrot habitat (e.g. critical nesting and foraging habitat).

Since 2019 sugar glider management has occurred in Tasmania, with nest boxes used as a primary capture method. However, a lack of understanding of the factors that affect glider use of nest boxes and other aspects of their ecology in Tasmania has led in some cases to low trap success. This study examined the factors that impact glider use of nest boxes including; nest box type (front/rear entry), bark type (rough/smooth), nest box height (4–7 m, 8–10 m, 10–13 m) and diameter at breast height (small 20–50 cm, medium 51–80 cm, large >80 cm). The project also examined how long it took for gliders to begin using the nest boxes, and the efficacy of 4G cameras as a nest box monitoring tool. A total of 80 nest boxes were deployed across two sites in the Southern Forests region. Gliders were detected during nest box checks on 11 occasions in 10 nest boxes. It took the gliders eleven weeks (Figure 5) to begin using the nest boxes, suggesting that short-term control programs (2–3 months) are unlikely to be successful. 4G cameras only reliably transmitted images approximately 60% of the time suggesting they are not a reliable trap monitoring tool, although they did provide valuable insight into the glider interactions with boxes. Unfortunately, gliders were not detected in a sufficient number of boxes to allow an assessment of nest box characteristics. However it was noted that gliders did use rear entry nest boxes (Figure 6), so these boxes could be deployed to target gliders in areas where swift parrot use is high. Overall, the results of the study suggest that glider control programs that use nest boxes as a primary trapping method must occur over longer periods (6–8 months or ongoing) to be effective.

To meet the second objective of the project, two conservation covenants in the Huon Valley and Glamorgan-Spring Bay Council areas were approved over the last financial year. A further two are awaiting final approval. They will cumulatively protect 198 ha and protect 83 ha of high value foraging habitat on private property. Participating landholders will receive support to improve the condition of this protected habitat.

Delivery partners for this project include Australian National University (ANU), Department of Natural Resources and Environment Tasmania (NRET), The Tasmanian Land Conservancy (TLC), Conservation Landholders Tasmania (CLT), pakana Services, Enviro Arb. The project is funded by the Australian Government as part of the project “Protecting the breeding population of swift parrots”. FPA sits on the steering committee for this project.

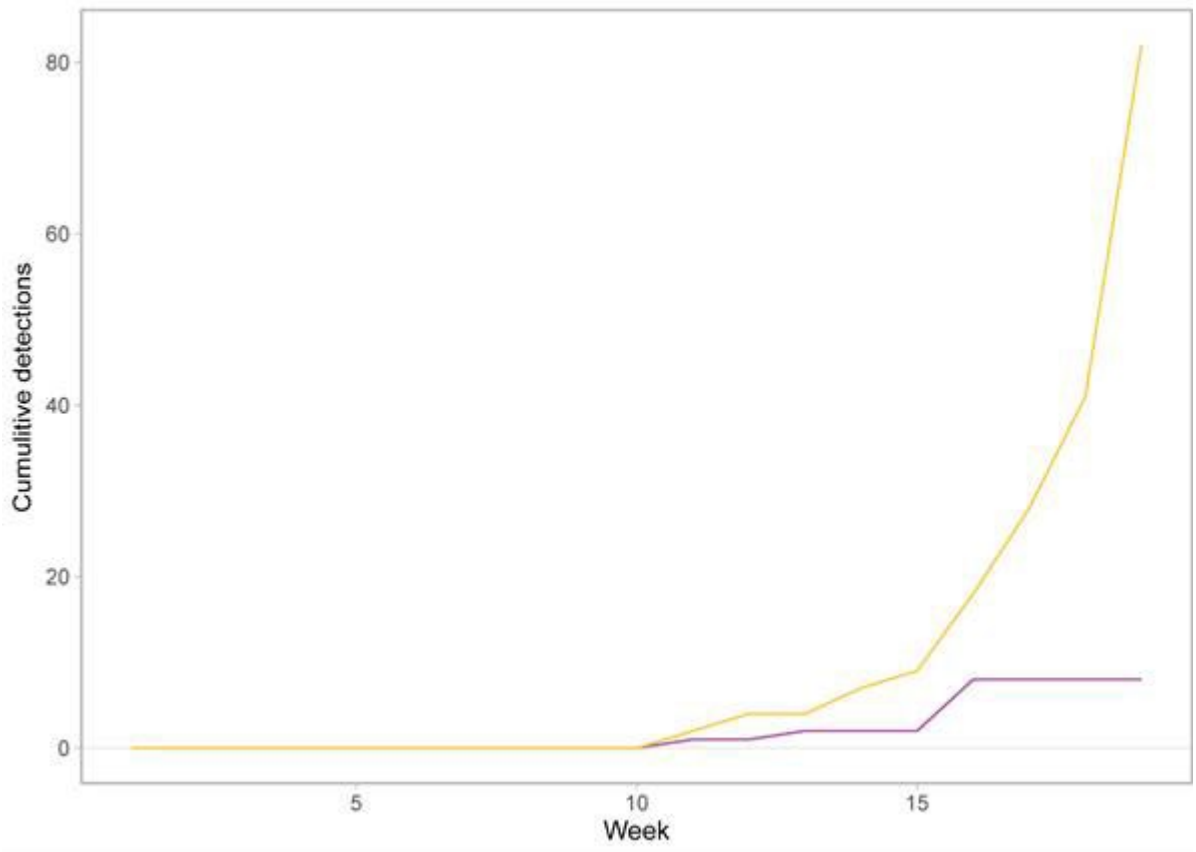


Figure 5. Cumulative detections of sugar gliders on camera traps facing nest boxes (orange line) and during nest box checks nest boxes (purple line).

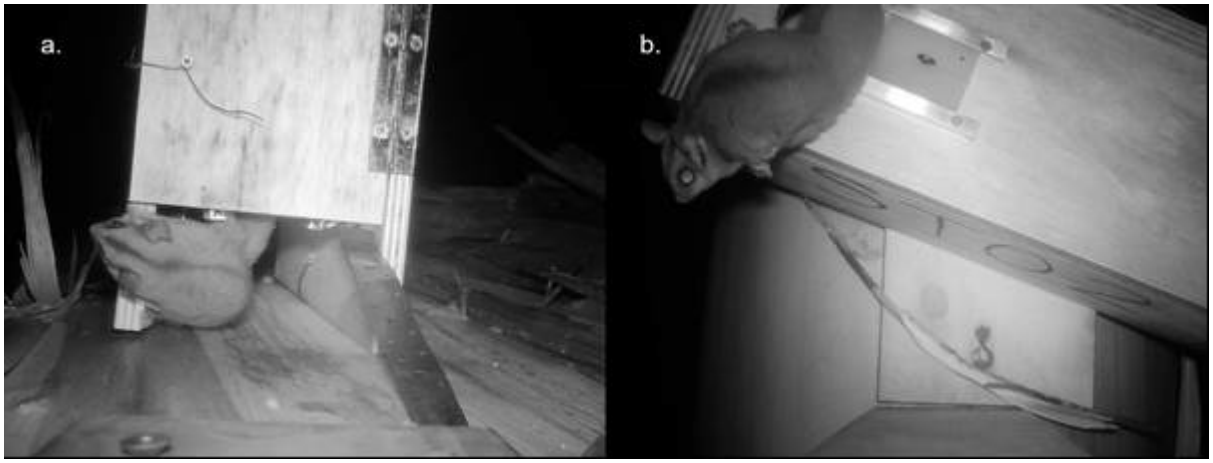


Figure 6. A glider exiting a) rear entry nest box and b) front entry nest box.

3.2.3. Forty-spotted pardalotes

Endemic to eastern Tasmania, the endangered forty-spotted pardalote (*Pardalotus quadragintus)* survives in small, isolated mainland populations in the island's south-east, as well as on offshore islands including Flinders, Maria and Bruny. It is under threat from the loss of its habitat (principally white gum *E. viminalis,* a critical feeding resource), its small

population size, and the death of nestlings due to the larvae of an endemic parasitic fly that can kill up to 81% of chicks in infested areas.

This project is working with the ANU to trial management strategies for forty-spotted pardalotes through:

- Testing whether dispensers containing insecticide-treated feathers can be applied at the landscape scale to help combat fly larvae in their nests on north Bruny Island.
- Investigating environmental variables that may influence nest box occupancy by forty-spotted pardalotes.
- Running a population viability analysis to investigate management scenarios for forty-spotted pardalote populations across their range.
- Using genetics to understand population parameters that will be crucial to inform management interventions that account for genetic diversity.

Trials of the feather dispensers at landscape scale are underway and will be completed during the 2022–23 year. The genetics data has been collected and processed and this work is currently being prepared for publication. The surveys on nest box data from a variety of islands around Tasmania were collated. Analysis of the data is underway. This project is funded by the Australian Government.

3.2.4. Eastern barred bandicoots

The eastern barred bandicoot (*Perameles gunnii*) is extinct in the wild on mainland Australia but remains relatively common in many areas of Tasmania. However anecdotal evidence and records databases (Atlas of Living Australia, Natural Values Atlas and spotlighting records from DPIPWE since 1975) suggest the eastern barred bandicoot (hereafter bandicoot) may be declining, particularly through the Midlands region. Management recommendations for this species are delivered via the Threatened Species Adviser.

UTAS PhD candidate, Joanna Lyall, is trying to understand more about the habitat requirements of this species. At this stage the reasons for the decline are unclear, but loss of habitat, intensification of agriculture and an increase in cat numbers are believed to be contributing factors. Jo has completed two three-month rounds of camera trapping across northern Tasmania. She has a huge number of images to process. She will then relate the presence of a range of animals to site attributes such as vegetation density, vegetation type, canopy, shrub and ground cover, height and density. This will be followed by some GPS/VHF tracking of eastern barred bandicoots to determine where they are nesting and foraging and how great a risk they face from harvesting operations on agricultural land.

3.2.5. Threatened burrowing crayfish

Claws on the Line - monitoring Tasmania's burrowing crayfish

Five species of burrowing crayfish are managed under Tasmania's forest practices system. In November 2019 the Bookend Trust launched a program to map and monitor Tasmania's burrowing crayfish populations, Claws on the Line. This is part of the NatureTrackers program. Additional aims of this program are to improve public understanding of the science and to unite threatened burrowing crayfish recovery efforts. The initial focus is on the endangered Central North burrowing crayfish (*Engaeus granulatus*, or CNBC), which is endemic to a small region surrounding Devonport and Latrobe, through which it is very thinly scattered. The species' area of occupancy is estimated as less than 100 ha, and is shrinking. The project invites participants to share location records of burrows and other crayfish signs via the app iNaturalist (on which precise locations can be hidden), as part of the iNaturalist project Claws on the Line. Questionnaires and other public engagement efforts provide additional avenues for reporting locations and recognising crayfish burrows (details on naturetrackers.com.au/projects/claws-on-the-line). If regular monitoring can be achieved, this will ultimately provide accurate, up-to-date information on the species' area of occupancy, and enable detection of any significant changes.

At the time of writing, contributions so far comprise 227 observations from 47 people on iNaturalist's Claws on the Line project, along with 20 more provided via the questionnaire. Burrow records, as 'Australian burrowing crayfish', are shared with the Natural Values Atlas, and their locations are gradually being visited for identification by the expert team, although there are also plans to develop lower-effort identification methods. Confirmed observations from these sources and the Natural Values Atlas were used by University of Tasmania undergraduate Wade Bone to create an initial, biologically plausible species distribution model for the CNBC. High quality habitat was predicted along many waterways and drainage catchments and related to soil clay content and stream density variables. Ground-truthing for the model resulted in discovery of previously undocumented colonies. Additional field surveys and higher resolution raster data will allow refinement of model predictions.

To further support data collection and overall public engagement, an annual event was launched in spring 2020, when the species becomes more active and apparent. This involves visits to schools and the community within the CNBC's range and an art competition for primary school students, in collaboration with governmental and non-governmental organisations, corporates and interested individuals.

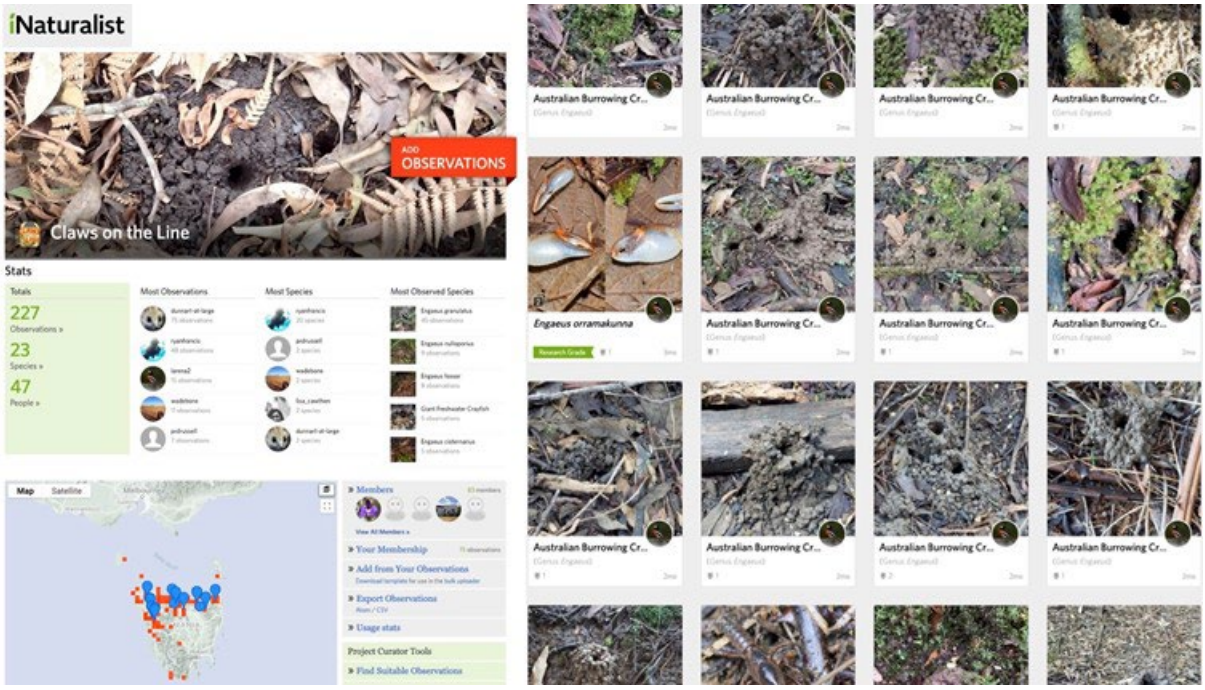


Figure 7. Records of Tasmanian burrowing crayfish chimneys and other signs, on the iNaturalist project Claws on the Line www.inaturalist.org/projects/claws-on-the-line.

3.2.6. Bornemissza's stag beetle

Bornemissza's stag beetle (*Hoplogonus bornemisszai*) is listed as endangered under the *Threatened Species Protection Act 1995* and Critically Endangered under the *Environment Protection and Biodiversity Conservation Act 1999.* The species is apparently relatively abundant within wetter forest communities within its range, but uncommon in drier forest types. Bornemissza's stag beetle has a very restricted range (~700 ha within a 11 km^2 extent of occurrence) in north-eastern Tasmania (Richards and Spencer 2021), where this flightless beetle occupies damp areas on the forest floor, with the leaf litter layer being vital to the species survival.

Historical logging has occurred throughout much of the beetle's range (Richards and Spencer 2021). In forestry areas management recommendations, delivered via FPA's Threatened Species Adviser, include retaining at least 20% of potential habitat in streamside reserves and wildlife habitat clumps.

A long-term monitoring project by Richards and Spencer (2021) investigated the impact of partial harvest and planned burns and the effectiveness of current management. While the standard survey method for stag beetles involves leaf litter searches, this study adopted a novel technique of doing pit excavation for larvae. A comparison of the two techniques found pit excavation to be a better method for monitoring response to disturbance.

Twelve survey sites were set up in the coupe: three in the harvested but unburnt areas within the coupe, three in the harvested area associated with the bark heaps that were

burnt, three in retained clumps and three in unharvested adjacent forest. Three larval pits were dug at each site. The sites were surveyed post-harvest in 2008, and then annually for nine years after the bark heaps were burnt in 2009.

The authors found that harvesting and fire events resulted in the temporary loss of the species, leading to population fragmentation. The loss of species was not recorded in the control areas (retained clumps or intact adjacent area). Recruitment appears to occur after a time with larvae observed in some, but not all of the treatment sites, about seven years after the burn. The authors conclude that species persistence is dependent on the recovery of suitable habitats within an appropriate time frame. The study confirms the importance of retaining suitable habitat intact both within and adjacent to the harvest operation, to allow persistence and recruitment (Richards and Spencer 2021).

Figure 8. Head of a male Bornemissza's stag beetle (photo: Karen Richards).

3.3. Other miscellaneous projects relating to Tasmanian forests

A range of other Tasmanian projects relate to forest ecology and management, but not to the effectiveness of the biodiversity provisions of the forest practices system. A subset of these projects is listed below.

Agroforestry

- Marais et al. (2022) looked at the contribution of shelterbelt characteristics on ecosystem services in the Midlands of Tasmania. The study found that benefits of ecosystem services are likely to be dependent on the species composition of the shelterbelt.
- Monckton and Mendham (2022) undertook a desktop review of how to maximise the benefits of trees on farms. The review discusses seven key areas in which to invest time and resources to encourage tree growing on farms.

Carbon

- McIntosh et al. (2022) found that in north-west Tasmania, eucalypt plantations on ferrosol soils did not have significant differences in the amount of soil carbon comparative to adjacent native forests.
- Ndalila et al. (2022) highlighted the need to include CO_2 emissions from planned and unplanned burns in carbon accounting in Tasmania to ensure accurate data.
- Paul et al. (2022) expanded the capability of the FullCAM carbon accounting model to refine carbon sequestration figures for plantations and agroforests.

Climate change

- Butler et al. (2022) modelled spatial variation in climatic adaptation within *E. globulus*. Results from the study suggest that under a changing climate more than half of the current distribution of *E. globulus* will be outside the modelled adaptive range by 2070 and therefore at risk from not being adapted to climatic changes.
- Harrison (2021) presents an experimental framework that assists restoration decision-making by analysing suitability of local and non-local native species for landscape restoration under current climates and predicted climate change. Results found that mixing local and non-local seed when restoring ecosystems will allow for greater variability and adaptability to future climates.
- Slee and McIntosh (2022) found that potential increases in high-intensity rainfall under a changing climate may promote landslides on steep slopes on which forest plantations have been harvested from. Slee and McIntosh suggest that landslides and riparian areas should be seeded with native vegetation to stabilise soils and reduce landslide risks in these areas.
- Wardlaw (2022) found that during a protracted warm spell, wet eucalypt forests in southern Tasmania become a carbon source, switching from their usual function as a carbon sink. With these warm periods predicted to increase under a changing climate this has ongoing implications for future carbon sequestration in these forests.

Ecological restoration

- A major project has been underway to help restore the ecological integrity of the Midlands in Tasmania. A recent study by Davidson et al. (2021) discussed methods used for landscape-scale revegetation efforts in the Midlands, including detailing failures and successes.
- Dudley et al. (2021) detail a project that restored an area of approximately 200 ha that was historically used for pine plantations, back to native forest vegetation.
- Robinson et al. (2022) discuss the merits and future potential of using unmanned aerial vehicles (UAV – drones) in undertaking ecological restoration.

Environmental toxins

- Hampton et al. (2022) discuss the issues around using lead-based ammunition for macropod management in Tasmania (and Australia). The paper suggests alternatives to lead based ammunition for better environmental and animal welfare outcomes.
- Pay et al. (2021a) looked at the secondary effects of anticoagulant rodenticides (ARs), used to manage mammalian pest populations on Tasmanian wedge-tailed eagles. The study detected high levels of AR residues, and concentrations of second generation ARs in carcasses analysed. Pay et al. (2021a) highlight the need to address non-target AR exposure in predator species, such as the wedge-tailed eagle.

Fire

- Furlaud et al. (2021) looked at forest fire risk in wet Tasmanian *Eucalyptus regnans* forests. A difference in fuel load levels meant that older forests had a significantly reduced fire risk compared to forests in earlier successional stages. The study noted that disturbances to the older forests put them at increased risk of high-severity fire and therefore careful management is required for these forest types to reduce risk.
- Allen et al. (2022) used tree-rings to determine historical fire danger. They found that fire danger has consistently been high from the year 2000 CE onwards, with an increase in the past four decades indicating changing climatic factors.
- Henry et al. (2022) found the impacts of fires on taxon composition of invertebrate communities in alpine Tasmanian areas persist for many decades following fire.
- Kirkpatrick and Jenkinson (2022) compared the effectiveness of planned burns and mechanical removal of *Allocasuarina verticillata* to reduce woody thickening in Tasmanian grasslands. The study found the most effective method to reduce woody thickening was a combination of mechanical removal of young *Allocasuarina* and planned burns undertaken at five-year intervals.
- Prior et al. (2022) found a high survival rate of overstorey eucalypts following fires of low to moderate intensity and severity in Tasmanian tall wet eucalypt forests (TWEF). This survival leads to multi-aged stand structure in most old growth TWEF in Tasmania. The study contrasted this finding with wet forests harvested under clearfell, burn and sow regimes, which result in even aged stand of young regrowth, which can be more vulnerable to wildfires. Prior et al. (2022) suggest that using partial harvesting systems may alleviate some of these vulnerabilities in wet forests used for timber production.
- Kasel et al. (2022) looked at the seed bank of wet forests in south-eastern Australia in relation to fire and timber harvesting. They found that hard-seeded species (dispersed by ants) in the soil seed bank responded positively to fire related germination cues, while early successional species did not respond to fire cues. The

authors concluded that heterogeneous environments will benefit biodiversity conservation.

Forest biogeography

- Kirkpatrick (2022) looked at the role geographical isolation played on plant species occurrence and composition in Tasmanian *E. regnans* forests. The study found insignificant isolation effects from a geographical barrier (Bass Strait) indicating that corridor creation between large areas of human modified landscapes in conservation planning may not be as vital as previously thought.

Forests in drought

- Britton et al. (2022) looked at xylem cavitation in Tasmanian native trees and found that drought damage is affected by both the individual physiology of the tree and the surrounding vegetation stand density.
- Pritzkow et al. (2022) used x-ray tomography to determine that xylem embolism in Tasmanian eucalypts conduits in a circumferential pattern, noting that conduit connectivity as opposed to size is likely to be the main influential variable on embolism occurrence.
- Wardlaw (2021) describes the physiological impact of a warming climate on the health and productivity of Tasmanian eucalypt forests.

Remote sensing and spatial analysis

- A study by Hillman et al. (2021) analysing remote sensing technology determined that both unoccupied aircraft systems and LiDAR point clouds can be used to determine fire severity at a high spatial resolution.
- Iqbal et al. (2021) determined that digital aerial photogrammetry (DAP) can provide forest data (i.e. canopy structural metrics, the number of trees per hectare etc) at similar spatial scales to data derived from airborne laser scanning, with the former being a more cost-effective alternative.
- Krisanski et al. (2021) present an open-source tool for developing high-resolution forest point clouds.
- Yadav et al. (2022) used digital terrain models to predict eucalypt forest density. They found that geology had the highest predictive importance in determining density, out of the 12 topographic attributes analysed.
- Yadav et al. (2021) used different combinations of remote sensing datasets to identify overstorey and dominant understorey species. This study found that a combination of hyperspectral and LiDAR data was the most effective method to accurately identify species remotely.

- Yates et al. (2022) analysed spatial patterning of fallen logs (line-segment data) to provide a greater understanding of the ecological role of tree fall in forest communities.

Threatened species

- Pay et al. (2021b) present a novel methodology using morphological characteristics for accurate identification of the sex of individual Tasmanian wedge-tailed eagles.
- Pfeilsticker et al. (2022) looked at the hybrid vigour of crosses between the threatened eucalypt species *E. risdonii* and non-threatened *E. amygdalina.* The study found a decrease in vigour for the hybrid seedlings, with fitness rapidly recovering following backcrossing. Thus the hybridisation process may contribute to a range expansion of *E. risdonii* under a changing climate.
- UTAS PhD candidate, Kawinwit Kittipalawattanapol, is investigating how black rats (*Rattus rattus*) fit in the ecological food web and explore how populations of black rats and swamp rats are impacted by the decrease in Tasmanian devil populations, increase in feral cat populations, habitat conditions, and habitat structures. According to preliminary camera survey, 95% of camera detections of all small mammals are the super-invasive black rat.

During the past year NRM South conducted the following three projects, funded by the Australian Government under the project "Protecting some of Australia's most threatened flora and communities: Morrisby's gum, Southport heath, and black or Brookers gum forests and woodlands".

- Tasmanian forests and woodlands dominated by black gum (*E. ovata*) or Brookers gum (*E. brookeriana*) is a critically endangered vegetation community. It is at risk from clearing, habitat altering weeds, grazing pressure and threats associated with poor land management practices. NRM South are undertaking a project to raise awareness of this forest community and improve conservation by promoting covenanting of this community. They have helped establish five Forest on Farms management agreements and property action plans with private landholders. Landholders will receive funding and support to deliver the recommended actions in these plans over the next year.
- Morrisby's gum (*E. morrisbyi*) is listed as endangered in both State and federal legislation. This project being managed by NRM South and delivered by Enviro-dynamics aims to improve the status of Morrisby's gum by protecting remaining plants (from browsers, insect attack, wildfire, and extreme hot and dry conditions), connecting remnants and establishing seed orchards (through support for landholder, school, and community group plantings), extending the species' distribution into its future climatic range and enhancing the quantity and genetic diversity of seed bank reserves. Over 2021–22 four landholder agreements were

formalised to ensure the protection of conservation plantings of Morrisby's gum. The plantings were completed at three of the landholder sites over the 2022 winter, with 2,430 Morrisby's gum seedlings planted. Seeds were collected for storage and conservation of the genetic material of this species.

- Southport heath (*Epacris stuartii*) is listed as endangered at a State level and Critically Endangered at the federal level. It occurs naturally at only one remote location which is within a reserve. There is an insurance population on an island near the wild population (Southport Island), but the species remains under threat from fire, weeds and a changing climate. Working in partnership with NRET, the Tasmanian PWS, the Tasmanian Seed Conservation Centre, Threatened Plants Tasmania and pakana Services, NRM South are putting in place measures to safeguard mainland and island populations of Southport heath. Actions include removing high priority weeds, boosting the seedbank reserve, finding out more about the optimal conditions for germinating seeds and raising awareness about the species in the local community.

4. Reviewing current practices in light of new information

In 2021–22 a number of changes were made to biodiversity management as a result of new information and research.

- In the summer of 2020–21, the FPA became aware of new information that suggested that *Eucalyptus brookeriana* was likely to constitute an important foraging resource for swift parrots in the Eastern Tiers area. The FPA, in consultation with NRE Tas, undertook a process to evaluate this new information under the Process for the development, review and continual improvement of the provisions of the Forest Practices Code. A revised management approach was developed for swift parrot habitat within the Eastern Tiers to include the identification and management of *E. brookeriana* as potential swift parrot foraging habitat. The management approach focuses on the retention of *E. brookeriana* dominated forest, as well as retention of larger *E. brookeriana* individuals, as botanical information suggests that the larger *E. brookeriana* trees have the potential to contribute a more substantial foraging resource. This approach has been endorsed by the FPA and NRE Tas under the procedures for the management of threatened species under the Forest practices system, and was incorporated into the Threatened Species Adviser in June 2022.
- The endorsed approach for managing swift parrot habitat within wood production areas is based primarily on the category of breeding range in which the coupe is located. The swift parrot has three main categories in the southeast: potential range, core range and Swift Parrot Important Breeding Area (SPIBA). The risk to the species of habitat loss from forestry activities is considered to increase from potential range (lowest risk) to SPIBA (highest risk). Recommendations to manage habitat are delivered through the Threatened Species Advisor and contain an increase in habitat retention levels as risk increases. Therefore, coupes within SPIBAs have a significantly higher habitat retention recommendation compared to coupes within the potential range. The Lonnavale area (encompassing Denison/Russell/Barnback forest blocks) area is located within the potential range for the swift parrot and until late 2021, contained 17 swift parrot records on the Natural Values Atlas (NVA). In 2021–22 a significant number of additional swift parrot nests and sightings in this area were added to the NVA. Following the addition of these records, the Threatened Species Management Group (TSMG) recommended that the range category of the Lonnavale forest area should be reviewed to determine the appropriate habitat management approach under the forest practices system. To minimise the potential risk of habitat loss while the review process is conducted, in December 2021 the CFPO issued an instruction that the Threatened Species Adviser recommendations could no longer be used for planning coupes within the Lonnavale forest area and that advice should be sought from the FPA biodiversity program on a case-by-case basis. FPA and NRE Tas initiated a multi-faceted review of information

relating to habitat extent, quality and quantity in the Lonnavale area in 2021–22. This review will continue through 2022–23.

- Four flora species were newly listed as threatened: *Chiloglottis valida* (large bird orchid), *Senecio extensus* (subalpine fireweed), *Senecio longipulus* (longhair fireweed) and *Senecio tasmanicus* (Tasmanian fireweed). Management recommendations were developed for these species in consultation with Tasmanian botanists.
- Two flora species were delisted under the *Threatened Species Protection Act* 1995 during the 2021–22 period; *Epilobium pallidiflorum* (showy willowherb) and *Hierochloe rariflora* (cane holygrass). These two species were removed from the BVD and Threatened Species Adviser accordingly.
- Fauna Technical Note 1 – Eagle nest management was reviewed and refined in consultation with eagle experts and stakeholders.
- Flora Technical Note 8 – Management of *Phytophthora cinnamomi* in production forests was updated to ensure that current research and knowledge is incorporated into the technical note.

5. Discussion and 2022–23 priorities for biodiversity monitoring

Research in 2021–22 continues to improve our understanding of the effectiveness of the *Forest Practices Code* provisions for biodiversity.

The majority of the research focused on threatened species, their habitat requirements and how they respond to disturbance or landscape management. A number of these studies noted that retained areas can play a really important role in managing threatened species.

This reporting period had a greater focus on the implementation of management recommendations for threatened species than has been seen in previous years. This line of research is extremely important because when assessing the effectiveness of management, it is important to know that management is being implemented correctly.

Some new initiatives, looking at broader issues such climate change, post-disturbance harvesting and the relative value of land 'sparing' versus land 'sharing', are also helping ensure the forest practices system can adapt and respond to emerging issues.

The forest practices system continues to adapt to emerging information, most notably with changes occurring to swift parrot management in light of new ecological information.

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