Annual Progress Report 2023-24
Private Native Forestry Monitoring Program
November 2024

Natural Resources Commission

The annual progress report has been prepared by the Natural Resources Commission on behalf of the **NSW Forest Monitoring Steering Committee**.

Natural Resources Commission · Local Land Services · Crown Lands · Department of Primary Industries and Regional Development · Department of Climate Change, Energy, the Environment and Water

National Parks & Wildlife Service · Aboriginal Affairs NSW · nsw epa · Forestry Corporation

The University of Sydney · The University of Melbourne · Australian National University

Acknowledgement of Country

The Natural Resources Commission acknowledges and pays respect to traditional owners and Aboriginal peoples. The Commission recognises and acknowledges that traditional owners have a deep cultural, social, environmental, spiritual and economic connection to their lands and waters. We value and respect their knowledge in natural resource management and the contributions of many generations, including Elders, to this understanding and connection.

List of acronyms

CEO	Chief Executive Officer
DPIRD	NSW Department of Primary Industries and Regional Development
DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
EPA	NSW Environment Protection Authority
IFOA	Integrated Forestry Operations Approval
LLS	Local Land Services
MER	Monitoring, Evaluation and Reporting
NRC	Natural Resources Commission, 'the Commission'
NSW	New South Wales
PNF	Private Native Forestry
SLATS	Statewide Landcover and Tree Study

Table of Contents

1   Private Native Forestry Monitoring Program

In New South Wales, private native forestry (PNF) is the ecologically sustainable management of native forests on private property to produce timber or other forest products. The rules for conducting native forestry on private land are set out in four PNF codes of practice (PNF codes), established under the *Local Land Services Act 2013* (NSW) (**Figure 1**).[1]

The PNF codes released in May 2022 introduced new requirements for monitoring, assessment, and adaptive management. The codes task the NSW Forest Monitoring Steering Committee (the Steering Committee),[2] independently chaired by the Natural Resources Commission (the Commission), to:

- propose and oversee a PNF Monitoring, Evaluation and Reporting (MER) Framework

- conduct annual checks to ensure the evidence base, including maps, is up to date, identify emerging evidence from monitoring and research, and opportunities for improvement

- formally assess the data and evidence every five years and advise relevant Ministers whether there is sufficient evidence to warrant a review of the codes[3]

- oversee updates to the PNF Koala Prescription Map.[4]

The PNF MER Framework proposed by the Steering Committee was jointly approved by the Chief Executive Officer (CEO) of Local Land Services (LLS) and the Secretary of the then Department of Planning and Environment in November 2023.[5]

Table 1 sets out the agencies and experts involved in the Steering Committee, including:

- NSW agencies with responsibilities for natural resource and environmental policy, regulation, science and monitoring, and forest management

- four independent experts providing advice on biodiversity, forestry, fire ecology, and soil and water.

This is the second annual progress report for PNF MER program.

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[1]   Part 5B of the *Local Land Services Act 2013* sets out the objects, definitions and requirements for private native forestry.
[2]   Natural Resources Commission (2023) *Program governance and engagement*.
[3]   Relevant Ministers are the Minister administering the *Forestry Act 2012*, the Minister administering the *Local Land Services Act 2013* and the Minister administering the *Biodiversity Conservation Act 2016*.
[4]   See clauses 4.3 (2) and (3), and koala prescriptions in Appendix A, of the PNF codes.
[5]   Natural Resources Commission (2023) Approved Private Native Forestry Monitoring, Evaluation and Reporting Framework.
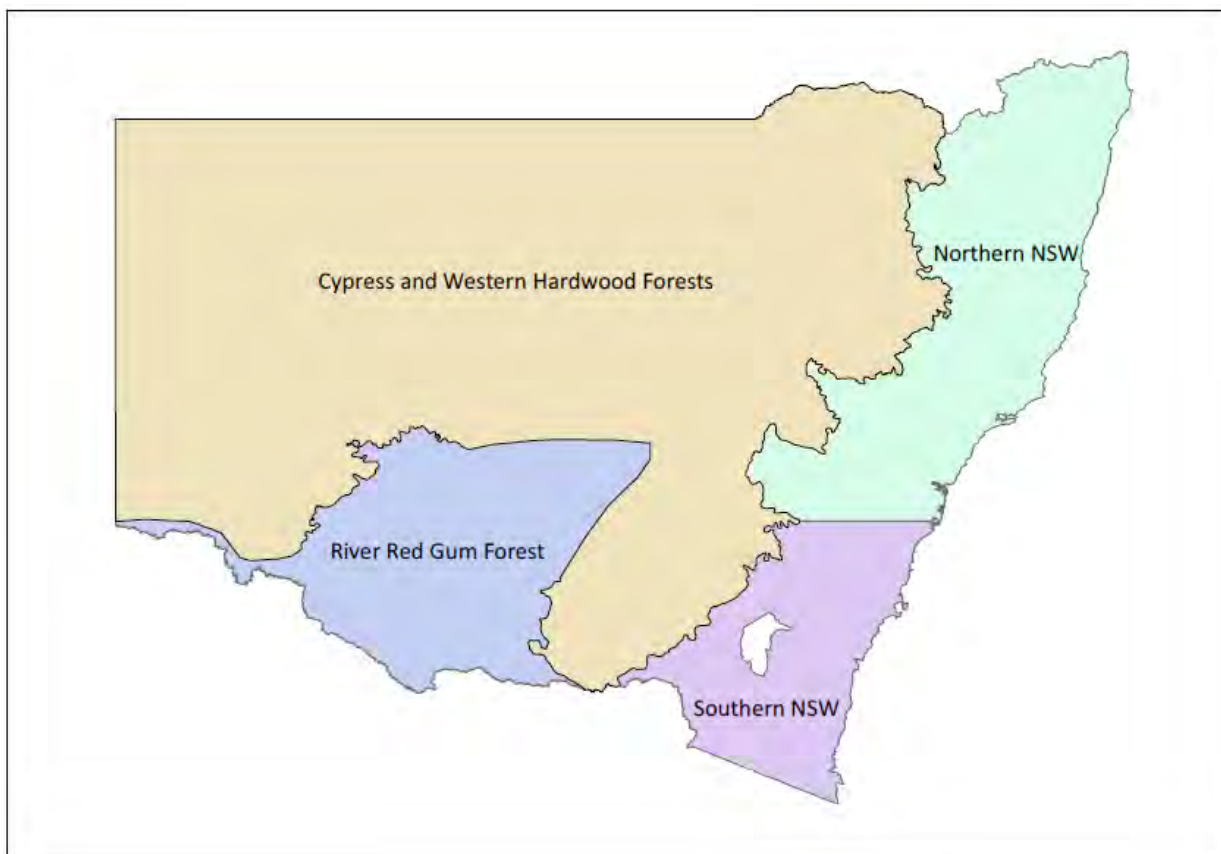
Figure 1: PNF code of practice regions in NSW[6]

Table 1: NSW Forest Monitoring Steering Committee composition

NSW Government agencies	Independent experts
▪ Natural Resources Commission (Chair) ▪ Local Land Services (LLS) ▪ Environment Protection Authority (EPA) ▪ Department of Climate Change, Energy, the Environment and Water (DCCEEW) ▪ Department of Primary Industries and Regional Development (DPIRD) ▪ Aboriginal Affairs NSW ▪ National Parks and Wildlife Service (NPWS) ▪ Forestry Corporation of NSW (FCNSW) ▪ Crown Lands	▪ Professor Patrick Baker, University of Melbourne ▪ Professor Phillip Gibbons, Australian National University ▪ Associate Professor, Tina Bell, University of Sydney ▪ Dr Peter Hairsine, Australian National University

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[6]   PNF codes for Northern NSW and Southern NSW regions, apply to all forests in those regions except those that meet the definitions of river red gum forests, cypress forests or western hardwood forests.

2   Progress and achievements in 2023-24

Table 2 outlines the status of program delivery since the PNF codes were released in May 2022. The remainder of this section details the projects completed or commenced in 2023-24. Monitoring and research findings are provided in subsequent sections.

Table 2: Progress dashboard

PROGRESS DASHBOARD		
Develop the PNF MER Framework and implementation plan		
Framework endorsed by Steering Committee, July 2023	**Completed**	✓
Framework approved by CEO LLS and Secretary DPE, November 2023	**Completed**	✓
Oversee LLS development of implementation plan	**In progress**	》
Research and evaluation projects		
Remote sensing feasibility study	**Completed**	✓
Process to verify and improve the PNF koala prescription map and underlying models		
Evaluate map and models and propose approach to validate and update	**Completed**	✓
Develop guidance for identifying high value koala habitat	**Completed**	✓
Oversee LLS development of protocol for landholder requested verification of the map at a property scale	**Completed**	✓
Validate the PNF koala prescription map using independent vegetation survey data at a state-wide scale	**Completed**	✓
Prepare updated koala habitat model and model inputs	**In progress**	》
Prepare next draft PNF Koala Prescription Map	**2025**	》
Risk-based review of threatened species protections		
Develop shortlisting approach and apply to threatened species in Appendix A of the PNF codes to identify key species	**Completed**	✓
Develop risk assessment framework and apply to key species	**Completed**	✓
Consider risk ratings and if further protections warranted	**Commenced**	》
Reporting and adaptive management		
Annual Progress Report 2022-23 (published July 2024)	**Completed**	✓
Annual check of the evidence base for 2023-24	**Completed**	✓
Annual Progress Report 2023-24 (published November 2024)	**Completed**	✓

2.1   PNF MER Framework approved

The Steering Committee submitted its endorsed PNF MER Framework to the CEO of LLS and the Secretary the then DPE, who jointly approved the Framework in November 2023.

LLS is preparing the PNF MER implementation plan and has primary responsibility to fund and deliver the plan under the PNF MER Framework. The implementation plan will detail the monitoring and targeted investigations to build the evidence base and inform decision making, longer-term reviews and adaptive management. Annual work plans will outline priorities aligned to available resources. The implementation plan will be finalised following delivery of the remote sensing feasibility study (see **Section 2.2**).

The Steering Committee, independently chaired by the Commission, will oversee implementation, and conduct annual checks of the evidence base and the formal five yearly assessment. The Commission will prepare and publish annual progress reports.

2.2   Remote sensing feasibility study completed

To support developing the PNF MER implementation plan, the Commission engaged experts to conduct a remote sensing feasibility study. The study team worked closely with a cross-agency technical review team and independent experts to investigate how remote sensing approaches could be used to facilitate broadscale monitoring for private native forestry.

The aims of the study were to:
- **Phase 1**: assess the capability of remote sensing technologies to monitor PNF code conditions and/or biophysical outcomes, and consider the feasibility of each remote sensing technology, including cost effectiveness, frequency of return sampling, usefulness of data generated, and whole-of-life-cycle considerations such as data storage, processing and analysis
- **Phase 2**: propose indicators to monitor biophysical outcomes and/or conditions under the PNF codes and analyse readily available remote sensing data to demonstrate what the data can explain in terms of outcomes and/or conditions.

Key findings from phase 1 include:[7]
- many of the code conditions can only be partially monitored using remote sensing only approaches
- remote sensing has a greater role in terms of bioregional scale monitoring, which is an appropriate scale for satellites such as Landsat and Sentinel to be used
- site scale monitoring needs airborne lidar and high-resolution imagery at a minimum and ideally other data and field measurements would complement this
- PNF monitoring should make use of existing products and programs where possible, noting that these may not be suitable for site scale monitoring
- any assessment of remote sensing costs needs to consider costs (and benefits) at all levels of the value chain, including processing and expertise costs.

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[7]   FlintPro (2023) Remote sensing of NSW private native forests – Options and feasibility. Report prepared for the NSW Natural Resources Commission.

Phase 2 of the study explored potential indicators for use in PNF monitoring.[8] A suite of 21 indicators were proposed with feasibilities ranging from low to high likelihood of success. The feasibility rating considered technical difficulty, ability to extract meaningful information and potential costs. Eleven indicators were selected for further consideration using available data to illustrate the usefulness of information and insights derived from their application.

While the study demonstrated there are various approaches that could be applied, it also showed that no single remote sensing system can provide all the necessary data suitable for the multi-scale spatial requirements required under the PNF MER Framework (i.e. site and bioregional scales). Ideally, to obtain monitoring insights at the necessary spatial scales requires the acquisition of data from multiple platforms, as well as onground observations, collected within a statistically defendable sampling strategy. The worked examples and potential indicators developed in the study provide a starting point for further development and analysis in the context of PNF monitoring with remote sensing.

LLS will now consider the findings from the remote sensing feasibility study as they develop the implementation plan.

2.3   Improving the koala prescription map and underlying models

The Commission's advice on finalising the PNF codes recommended the PNF koala prescription map be adopted as an interim map due to constraints during development, including time and availability of information and modelling.[9]

The Steering Committee is overseeing a process to verify and improve the PNF koala prescription map and underlying species distribution models. The aim of this large and complex project, which commenced in 2022-23, is to ensure koala prescriptions for PNF are applied in high value koala habitat areas. Critical to its success is cross-agency collaboration, and in particular the work of the DCCEEW Remote Sensing and Landscape Science Branch.

To input to this process, the Steering Committee established a cross-agency technical review team chaired by Peter Cochrane, Assistant Commissioner. Agencies represented include the Commission, LLS, DCCEEW, EPA, DPIRD and FCNSW. The Commission engaged independent experts to provide advice and support the project, including:

- Honorary Professor Jane Elith, University of Melbourne
- Dr Alistair Melzer, Central Queensland University
- Dr Natalie Briscoe, University of Melbourne.

Professor Elith has completed an evaluation of the existing PNF koala prescription map using tree species and cover data that was not used to develop the PNF koala prescription map or underlying models.[10] The evaluation found that although sensible relationships between the PNF koala prescription maps and independent data exist, these are not as strong as expected and do not explain much of the variation. The evaluation also considered the koala habitat suitability modelling that was used to create the maps. This finding supports revisiting the way in which the maps and underlying models were

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8   FlintPro (2024) Remote sensing of NSW private native forests – Application of potential indicators. Report prepared for the NSW Natural Resources Commission.
9   Natural Resources Commission (2022) Advice on finalising Draft Private Native Forestry Codes of Practice.
10   Professor Jane Elith (2024) Evaluating the existing Private Native Forestry Koala Prescription Map. Technical Report prepared for the Natural Resources Commission, August 2024.

developed. The evaluation was considered by other experts, including Dr Scott Foster a statistician with CSIRO, and the technical review team. Professor Elith's evaluation was endorsed by the Steering Committee in September 2024. The Commission has released a cover note providing background and a plain English summary of the analysis and findings.[11]

DCCEEW scientists and modellers have been working towards developing a new koala habitat suitability model for NSW. Key decisions for this modelling work have been informed by advice from the independent experts and agency scientists. During 2023-24 DCCEEW has been developing the inputs needed for the new model. This has included:

- refining and updating the list of koala browse tree species across NSW in consultation with experts

- preparing species distribution models for 81 koala browse tree species

- developing new native vegetation masks and tree species indices

- compiling and cleaning koala presence records

- compiling and selecting environmental predictors and bias covariates.

Modelling is currently in progress. Next steps include using independent, high quality koala presence and absence records to evaluate model outputs. Following completion of the modelling, DCCEEW will prepare a revised draft PNF koala prescription map, which will be tested using ground surveys of habitat quality. When endorsed by the Steering Committee, the Commission will submit the revised draft PNF koala prescription map to relevant Ministers for their consideration.

Changes to the PNF koala prescription maps require the joint approval of the Minister for Agriculture and the Minister for Environment.

2.4   Risk-based review of threatened species protections

The Commission's advice on finalising the PNF codes recommended the Steering Committee oversee a risk-based review of threatened species protections for key species in Appendix A of the PNF codes.[12] The Steering Committee commenced the risk-based review in 2022-23 and established a cross-agency technical review team chaired by Peter Cochrane, Assistant Commissioner. Agencies represented include the Commission, LLS, DCCEEW, EPA, DPIRD and FCNSW. The Commission engaged independent experts to provide advice and support the project, including:

- Dr Doug Binns, consulting flora ecologist

- Professor Philip Gibbons, Australian National University.

Ecological consultants, with input from the technical review team and independent experts, conducted a vulnerability assessment of the 256 threatened species listed in Appendix A of the PNF Codes. From this, 87 species (39 fauna and 48 flora) were shortlisted for detailed risk assessment. For each shortlisted species, ecological consultants conducted a literature review to collate the best available information on its habitat requirements and response to forestry or other similar disturbance.

A detailed risk assessment was conducted for each species at site and landscape scales if sufficient evidence was available. The assessment was informed by the literature review as

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[11]   Natural Resources Commission (2024) Cover Note – Validating the PNF Koala Prescription Map.
[12]   See Section 4.5 in Natural Resources Commission (2022) *Advice on finalising Draft Private Native Forestry Codes of Practice*.

well as spatial analysis of available modelling of the species distribution relative to PNF approved areas. Data deficient species were unable to be assessed. The risk assessment results will be used in 2024-25 to consider if further mitigation options or complementary measures are required for species with medium or higher risks identified at any scale.

The Commission will facilitate the next stage of this project working with the cross-agency technical review team and independent experts. The findings of this project are expected to be published in 2025.

2.5   Protocol for landholder review of koala prescription map

Working with ecologists in the DPIRD Forest Science Unit, LLS developed a protocol[13] for use when a landholder with an approved PNF Plan requests a review of the PNF koala prescription map on their property. The protocol was endorsed by the Forest Monitoring Steering Committee in September 2024.

2.6   Complementary projects will grow the evidence base

The PNF MER Framework recognises the importance of maintaining strong connections with the LLS Farm Forestry Program. The Farm Forestry Program is responsible for approvals under the PNF codes and provides advice and support services to PNF landholders. While not directly part of PNF MER implementation, LLS Farm Forestry Program undertakes complementary projects that support achieving outcomes under the PNF codes. These are shared here as they will generate evidence and insights to grow the PNF evidence base.

Research

As well as continuing to fund fauna acoustic surveys in north coast private native forests (**Section 3.3**), LLS is funding carbon and cross-tenure canopy disturbance research over the next four years.

The carbon research will inform an assessment of the effectiveness of silvicultural and other conditions of the PNF Codes in maintaining the health and productive capacity of private native forests, focusing on the Northern PNF Code region. Provision to reward the potential carbon benefits of active management of degraded native forests may also be established.

The cross-tenure canopy disturbance research will provide the basis for producing regular modelled canopy disturbance products across the non-woodland forests of NSW. This information will help inform and support decisions by LLS to suspend or reschedule harvest operations following an unforeseen event (such as wildfire, mass dieback or a forest biosecurity event) that may cause serious or irreversible environmental damage on private land at a bioregional scale.

Investigations

LLS are also funding experts at the Australian National University to complete desktop assessments of sustainable yields from private native forests in the River Red Gum and Cypress and Western Hardwood PNF Code regions.

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13   Local Land Services (2024) Protocol for verifying high koala habitat suitability.

Linked to the canopy disturbance research mentioned above, LLS is also funding a threshold analysis to help inform and support LLS decisions to suspend or reschedule harvest operations following an unforeseen event. This work is also considering whether results from the Coastal Integrated Forestry Operations Approval (IFOA) Monitoring Program, structured around the high priority conditions are likely to be directly transferable to PNF MER.

Capacity building

LLS is developing a landholder survey as part of PNF MER implementation planning that will be used to understand the effectiveness of capacity building activities. As well as these targeted annual surveys, LLS monitor attendance at capacity building events. In 2023-24, LLS sponsored four field days and nine training courses, attracting over 140 participants and covering topics such as:

- introduction to PNF
- managing fire affected forests
- grazing in a forest
- log grading
- silviculture and biodiversity
- forest inventory
- master tree growers.

Forest Stewardship Pilot

The Forest Stewardship Pilot awarded grants to 43 landholders, including two Local Aboriginal Land Councils and one Aboriginal co-managed property.

LLS provided participants with advice and financial incentives to improve forest stewardship on private property. This covered stand management, ecosystem management, fire management, roads and infrastructure, pest and weed control, cultural heritage, and education and training.

A final report from the pilot is expected in 2025.

3 Insights from data, monitoring and investigations

As the implementation plan is developed, other data and evidence are providing insights on private native forests and PNF.

3.1 New harvest data is adding to the evidence base

The PNF codes released in May 2022 require PNF Plan holders to submit a completion notification to LLS following forestry operations. The completion notification must include the approximate volume and area of harvest.

In 2023-24, LLS received 120 completion notifications from landholders, up from 87 notifications in 2022-23. **Table 3** provides the area and volume of harvest by relevant PNF code reported in these notifications for 2022-23 and 2023-24.

Table 3: 2022-23 and 2023-24 landholder reported harvest data

PNF Code	No. notifications received		Volume harvested (cubic metres)		Area harvested (hectares)	
	2022-23	2023-24	2022-23	2023-24	2022-23	2023-24
Northern NSW	82	108	83,314	100,661	5,516	6,518
Southern NSW	4	10	21,250	86,855	185	1,166
River Red Gum	-	2	-	19,700	-	200
Cypress & Western Hardwood	1	-	1,100	-	148	-
Total	**87**	**120**	**105,664**	**207,216**	**5,849**	**7,884**

Table note: Data supplied by LLS on 5 September 2024. Completion notifications are reported via several methods, and the data provided is not third party verified and is subjective in nature.

The accuracy and completeness of this harvest area and volume data is not known because they are estimates reported by PNF Plan holders and it is not known if all operations that occurred in the financial year submitted completion notifications. Over time, other datasets may provide evidence to better understand this data quality.

For example, when available, the canopy loss (harvest area) attributed to PNF by the Statewide Landcover and Tree Study (SLATS) for 2023 and 2024 will be compared with landholder harvest area estimates. SLATS uses Sentinel-2 satellite imagery to estimate annual rates of woody vegetation clearing across NSW. The most recent published SLATS data for canopy loss[14] (harvest area) attributed to PNF is provided in **Table 4**.

Table 4: Statewide area of canopy loss attributed to PNF harvest by the SLATS

Year	2018	2019	2020	2021	2022
Area (ha)	1,147	949	1,983	1,587	966

Source: 2022 NSW Vegetation Clearing Data (DCCEEW 2024)

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[14] Department of Climate Change, Energy, the Environment and Water (2024) 2022 NSW vegetation clearing report.

Other estimates of PNF harvest areas and volumes, include:

▪ A 2017 study used survey data from harvesting contractors to estimate annual harvest volumes from north coast private native forest were between 275,000 to 360,000 cubic metres per year with more than half of this comprising high quality sawlogs, poles, piles and girders.[15]

▪ A 2024 study used airborne laser scanning imagery (high resolution LiDAR) from 2020 and 2021 to derive PNF harvest estimates.[16] The methodology was applied to a stratified random sample of 253 private properties in northeast NSW, which enabled an estimate of the extent of selective harvesting across private native forests in northern NSW over a 1-year period. The estimated harvest area was 1,665 hectares (± 492 hectares at the 95% confidence level) or 0.37% (± 0.11%) across 455,000 hectares (total area with an approved PNF plan as of March 2020).

▪ In 2024 as part of the remote sensing feasibility study, SLATS data from 2017 to 2021 was intersected with PNF approved areas, as well as a canopy height loss model derived from available high resolution LiDAR (2020 and 2021) for the north east NSW.[17] Although this was a limited assessment, the study found that the SLATS derived area of harvest estimates appeared to be picking up a reasonable amount of the higher intensity PNF harvesting events. Detecting low intensity harvesting with moderate resolution satellites like Sentinel-2 is likely not possible.

These studies illustrate that targeted investigations using multiple data sources can support better understanding the accuracy of harvest area estimates derived from landholder reporting or satellite imagery.

To provide some scale to PNF operations relative to public native forestry in NSW, the harvest volume and area of public native forestry operations in 2022-23 was nearly 628,000 cubic metres and 11,700 hectares respectively.[18]

3.2   Higher rates of PNF approvals occurred in 2023-24

In 2023-24, LLS approved 418 PNF plans over an area of 84,945 hectares, with over 85 percent by area issued under the Northern NSW PNF Code of Practice. This is the greatest area of approvals in one year over the period of record shown in the public register, which covers the period 2011-12 to date. While 2023-24 approvals were high, some of these were reapprovals of expiring PNF plans. PNF approvals are granted for 15 years, and the first approvals made in 2008 when the original PNF codes were introduced expired in 2023. The number and area of reapprovals was not reported in 2023-24.

Figure 2 illustrates the area of PNF approvals from 2011-12 to 2023-24. It shows there has been an increasing trend in PNF approvals (by area) from a low in 2017-18 to date. The reason for the increasing trend in PNF approvals is not fully understood but contributing factors may include:

▪ challenging weather conditions (including drought and floods) prompting forest owners to draw on forestry as a supplementary income source to agriculture

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[15]   Jamax Forest Solutions (2018) Report on Survey of NSW North Coast Private Native Forest Harvesting Contractors. Report prepared for the NSW Department of Primary Industries.

[16]   Hislop, S., Stone, C., Samuel, J., Kathuria, A., Alaibakhsh, M. and Nguyen, T.H. (2024) Estimating the extent of selective timber harvesting in private native eucalypt forests with multi-temporal lidar. *Australian Forestry*, 86(3-4), pp.152-160.

[17]   FlintPro (2023) Remote sensing of NSW private native forests – Options and feasibility.

[18]   Forestry Corporation of NSW (2023) Sustainability Report 2022-23.

- reduced supply from public native forests following the 2019-20 fires creating increased demand to meet supply shortfalls from private native forests

- increasing effectiveness of LLS advice and support services in raising landowner awareness and capacity to participate in PNF.
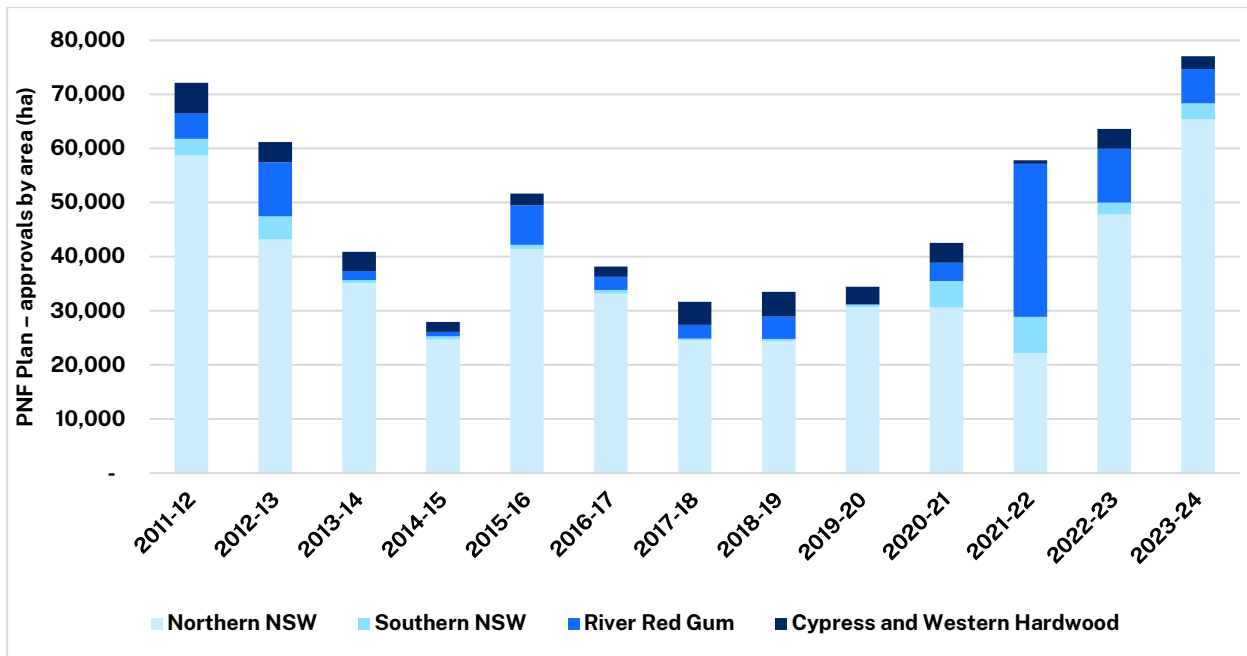

Figure 2: PNF plan approvals from 2011-12 to 2023-24

Data source: Public register data on LLS webpage Monitoring, Evaluation and Reporting.

The PNF codes released in May 2022 introduced a new requirement for PNF approvals to prepare a Forest Management Plan, unless the PNF approval is for small scale harvesting (no more than five trees per hectare). LLS approved 328 Forest Management Plans in 2023-24 covering 75,198 hectares. **Figure 2** shows the area with approved Forest Management Plans since May 2022.
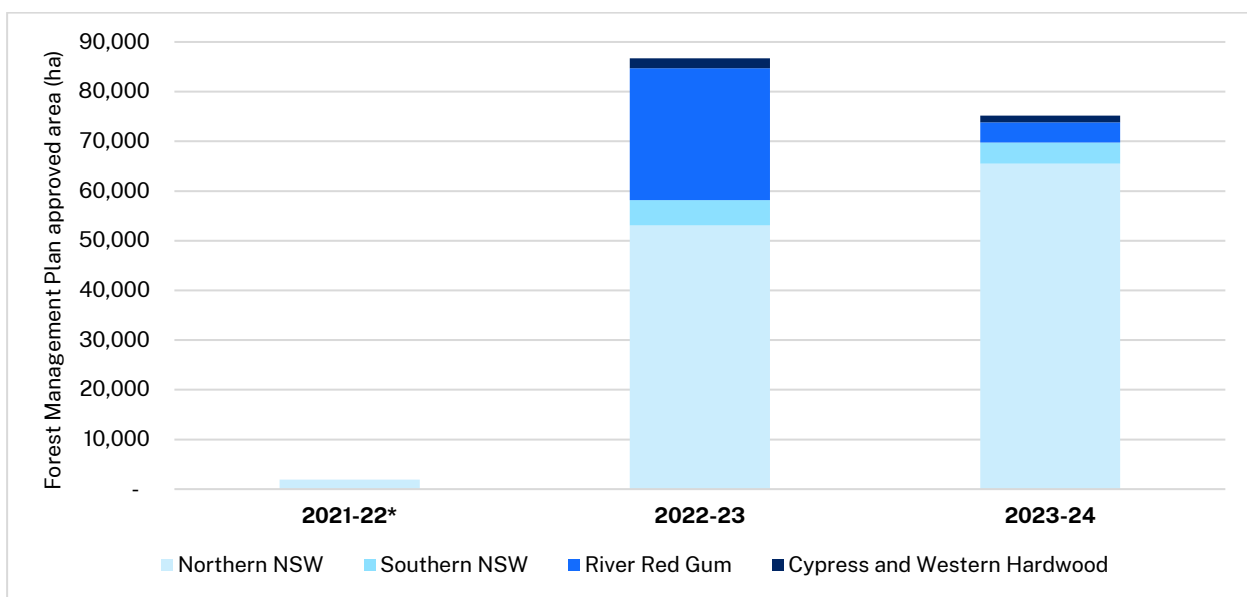

Figure 3: Forest Management Plan approvals from *May 22 to 2023-24

Data source: Public register data on LLS webpage Monitoring, Evaluation and Reporting

3.3 Fauna surveys are building the evidence base in private forests

LLS is working with the DPIRD Forest Science Unit who have been monitoring koala on private land since 2019. The DPIRD program, Countryside Koalas, was established under the NSW Koala Strategy using acoustic survey methods to provide a snapshot of koala occupancy across private forests in north east NSW.[19] Until this work, there were few systematic studies formally assessing koala occupancy in private native forests. The acoustic survey method relies on recording koala bellows made by the males during the spring breeding season. As of spring 2023, monitoring is in its fifth year and data are now being analysed to assess the trend in koala occupancy over that time.

As part of work being funded by LLS, DPIRD is now using call recognisers to reanalyse the koala acoustic archive and consider occupancy trends for a further 10 species:

▪ yellow-bellied glider

▪ sugar glider

▪ squirrel glider

▪ powerful owl

▪ sooty owl

▪ masked owl

▪ barking owl

▪ boobook owl

▪ grey-headed flying fox

▪ glossy black cockatoo.

Acoustic analysis for three species – koala, yellow-bellied glider and powerful owls – was undertaken in 2023-24. The preliminary results for naïve occupancy (number of site detections) show that koalas were detected much more frequently than either powerful owls or yellow-bellied gliders. However, further work is needed to account for annual differences in the probability of detection and variation in environmental covariates (such as koala habitat suitability).

Published data from the original surveys following the 2019-20 fires found koalas had a moderately high level of occupancy in private native forests.[20]

DPIRD recently undertook data analysis of the acoustic archive for yellow-bellied glider as part of a project funded by the Commonwealth Regional Bushfire Recovery for Wildlife and Habitat.[21] The aim was to describe the trend in yellow-bellied glider occupancy before and after the black summer fires in 2019 on the public estate (national parks and state forest) and to provide a baseline occupancy estimate for private forests, noting yellow-bellied gliders have not previously been the subject of formal surveys on private tenure. Median yellow-bellied glider occupancy was found to be substantially greater on the public forest estate than in private forests. On the private estate, occupancy was greater in more

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[19] DPIRD (n.d.) Countryside Koalas.

[20] Law, B., Kerr, I., Gonsalves, L., Brassil, T., Eichinski, P., Truskinger, A. and Roe, P. (2022) Mini-acoustic sensors reveal occupancy and threats to koalas Phascolarctos cinereus in private native forests. Journal *of Applied Ecology*, 59(3), pp.835-846.

[21] Law, B., Gonsalves, L., Brassil, T., Kerr, I. and Sawyers, E. (2024) *Acoustic surveys of Yellow-bellied Gliders in north-east New South Wales: occupancy monitoring in public forests and baseline surveys in private forests*. Unpublished report prepared by DPI for DCCEEW.

productive forests[22] and there was a minor negative effect on occupancy for extent of surrounding cleared land, recent harvesting and recent high severity fire. While the reason for the difference in occupancy between public and private forests was not able to be determined from this analysis, possible reasons suggested by the researchers may include the possible lower density of hollow bearing trees or forest fragmentation in the private forest estate.

In 2024-25, this monitoring project will continue with koala acoustic surveys in spring 2024. In addition to acoustic sensors, camera traps and ultrasonic records will also be deployed. These remote sensing techniques can be used to monitor trends in a range of species that can either be photographed with remote cameras that are triggered by movement or recorded using sound recorders for species that emit audible identifiable calls and ultrasonic sound recorders for echo-locating bat species. Over time, this monitoring can be used to detect trends in species occupancy.

3.4   Biodiversity outlook deteriorated following 2019-20 fires

The NSW Biodiversity Indicator Program released the second outlook report in 2024, which provides status and trends of biodiversity and ecological integrity.[23] Noting that data on biodiversity and threatened species is limited in the private forest estate, information from the Biodiversity Indicator Program may help to better understand potential broadscale trends in biodiversity and ecological integrity also affecting the private forest estate in NSW.

The Outlook report highlights that biodiversity in NSW is facing several pressures, including climate change, habitat loss and invasive species. Continuing and accelerating pressures have caused a decline in the state of biodiversity, including the percentage of threatened species and listed ecological communities expected to survive in 100 years.

The indicators also illustrate the significant pressures on biodiversity following the extensive 2019-20 fires. Between 2007 to 2017, indicators of ecosystem diversity, ecological condition and ecological carrying capacity were relatively stable. However, all three declined following the 2019-20 fires.

The Outlook report also notes that as at 2017, there were 305 invasive weeds and 36 pest animals known to occur in NSW. Invasive species are recognised as one of the major threats to biodiversity in Australia.[24,25] Section 6 of the PNF codes encourages landholders to manage pests and weeds on their properties and to seek advice from LLS or their local council on management of pest plants and animals.

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[22]   The Normalised Difference Vegetation Index (NDVI) was used to measure forest productivity, a metric derived from satellite sensors providing a measure of vegetation greenness, density and health.

[23]   DCCEEW (2024) NSW biodiversity outlook report 2024 Status and trends of biodiversity and ecological integrity.

[24]   Murphy HT, van Leeuwen S (2021). Biodiversity: Invasive species, problematic native species, and diseases. In: Australia State of the environment 2021, Australian Government Department of Agriculture, Water and the Environment, Canberra. DOI: 10.26194/ren9-3639

[25]   Ward, M., Carwardine, J., Yong, C.J., Watson, J.E., Silcock, J., Taylor, G.S., Lintermans, M., Gillespie, G.R., Garnett, S.T., Woinarski, J. and Tingley, R., (2021) A national-scale dataset for threats impacting Australia's imperilled flora and fauna. Ecology and Evolution, 11(17), pp.11749-11761.

3.5   Forest recovery following the 2019-20 fires

The 2019-20 fire ground covered 4.8 million hectares of NSW, with around 45 percent burnt at high or extreme severity.[26] Some plant and animal species had more than 80 percent of their habitat impacted by the fires.[27] While the second biodiversity outlook report[28] reported declines in ecosystem diversity, ecological condition and carrying capacity following the 2019-20 fires, there are signs that some species and ecosystems are recovering.

Post-fire biomass recovery monitoring can provide early indications of vegetation cover (but not structure and function) recovery at the landscape scale and is useful for identifying potentially vulnerable ecosystems with limited or delayed recovery.[29] Three years following the 2019-20 fires, biomass recovery monitoring indicates that:[30]

- around 90 percent of the total fire ground had reached stable vegetation cover

- 19 percent (425,000 hectares) of the areas impacted by high or extreme severity fire were mapped with limited or delayed post-fire recovery at the statewide scale

- nearly 24 percent of dry sclerophyll forests impacted by high or extreme severity fire had limited or delayed post-fire recovery of vegetation cover.

Recent research shows that even in the same area, some species show higher activity post-fire while others show decreased activity depending on a range of factors including fire severity, area burnt, vegetation type and time-since-fire.[31] NSW agencies have been monitoring the recovery of flora and fauna species following the 2019-20 fires. This has included sites in conservation reserves, state forests, as well as a limited number of surveys on private land. Much of this data is still being analysed and remains unpublished but is expected to be available in the coming year. Some examples of post-fire monitoring findings include:

- 58 motion-sensing cameras were set up in burnt, semi burnt and unburnt areas of Kosciuszko National Park, recording more than 40,000 images in just five weeks and confirming the smoky mouse was alive at seven burnt sites[32]

- a long-term study of yellow-bellied gliders in the Bago Plateau showed a reduction in occupancy of around 26 percent in 2020-21 following the fires[33]

- acoustic monitoring on the north coast showed that, in general, koala densities experienced greater declines in areas with a greater extent of medium or high fire severity, compared with areas with only low severity fire; koalas were temporarily

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[26]   NSW Department of Planning, Industry and Environment (2021) *Fire extent and severity mapping Annual report for the 2019–20, 2018–19 and 2017–18 fire years*.

[27]   Bradstock. R, Bedward, M., and Price, O. (2021) *Risks to the NSW Coastal Integrated Forestry Operations Approvals Posed by the 2019/2020 Fire Season and Beyond*, Centre for Environmental Risk Management of Bushfires, University of Wollongong and the NSW Bushfire Risk Management Research Hub, commissioned by the NSW Forest Monitoring Steering Committee, Sydney, NSW.

[28]   NSW DCCEEW (2024) *NSW biodiversity outlook report 2024 Status and trends of biodiversity and ecological integrity*.

[29]   NSW Department of Planning and Environment (2023) *NSW Post-fire Biomass Recovery Monitoring by Remote Sensing Report for 3 years following 2019–20*.

[30]   Ibid.

[31]   Miritis, V., Dickman, C., Nimmo, D. and Doherty, T. (2023) *After the 'Black Summer' fires: Faunal responses to megafire depend on fire severity, proportional area burnt and vegetation type*. *Journal of Applied Ecology*. 61. 1365-2664.14545. 10.1111/1365-2664.14545.

[32]   NSW Department of Planning, Industry and Environment (2021) *NSW Wildlife and Conservation Bushfire Recovery Supplement A – Assessing the impact of the bushfires on wildlife and conservation*.

[33]   Bilney, R.J., Kambouris, P.J., Peterie, J., Dunne, C., Makeham, K., Kavanagh, R.P., Gonsalves, L. and Law, B. (2022) *Long-term monitoring of an endangered population of Yellow-bellied Glider Petaurus australis on the Bago Plateau, New South Wales, and its response to wildfires and timber harvesting in a changing climate*. *Australian Zoologist*, *42*(2), pp.592-607.

absent in some areas where high fire severity dominated the landscape, but that koalas had begun to return in these areas after a year; both local and regional koala populations were found to relatively resilient following the fires[34]

- camera trap data collected in state forests south of Eden since 2007 shows that recorded observations of species had been declining steadily during the drought that preceded the 2019-20 fires; however, following the fires, higher rainfall provided better conditions and subsequent monitoring showed increased rates of species recorded such as the southern brown bandicoot, long-nosed bandicoot, bush rat, agile antechinus, and painted button quail; larger animals such as the common wombat, brush-tailed possum, swamp wallaby, lace monitor, short-beaked echidna and superb lyrebird continued to be at rates similar to those recorded before the fires and drought.[35]

There is emerging evidence the 2019-20 fires may result in a change in forest structure and habitat features in areas most severely burnt. A study in the coastal forests found the combined effects of the preceding drought and the 2019-20 high and extreme severity fires lead to an atypical response where the smallest and largest trees were more likely to be killed or topkilled.[36] This has implications for structural change in some forests resulting from the shift towards mid- and smaller-sized trees, and for the future hollow-bearing tree resource. This is due to the loss of larger diameter trees where hollows are more likely to be found.

In addition to the impact of changing climate, drought and fire regimes, the impact of pest animals and weeds on biodiversity and environmental outcomes in forests is significant. A study that considered baselines and trends in species across the coastal region of NSW found, in decreasing order of occupancy of mammal species, the feral cat (*Felis catus*) and red fox (*Vulpes vulpes*) were ranked fourth and fifth, respectively, in Eden forests, and fifth and tenth, respectively, in northeast forests.[37] The study recommended the threat posed by invasive predators to native fauna should be a key focus of future forest monitoring. The authors also found that climate change and fire will be key drivers of change and a threat to forest-dependent biodiversity and recommended that the species most sensitive to climate change should form a focus of future biodiversity monitoring.

34   Law, B.S., Gonsalves, L., Burgar, J., Brassil, T., Kerr, I, and O'Loughlin, C. (2022) Fire severity and its local extent are key to assessing impact of Australian mega-fires on koala (Phascolarctos cinereus) density. *Global Ecology and Biogeography*, 31(4), pp.414-726.

35   Forestry Corporation of NSW (n.d.) Wildlife monitoring shows species springing back after Black Summer. Webpage accessed 18 October 2024.

36   Bendall, ER, Collins, LC, Milner, KV, Bedward, M, Boer, MM, Choat, B, Gallagher, RV, Medlyn, BE and Nolan, RH (2024) Demographic change and loss of big trees in resprouting eucalypt forests exposed to megadisturbance. *Global Ecology and Biogeography*, p.e13842.

37   Kavanagh, R, Law, B, Drielsma, M, Gonsalves, L, Beaumont, L, Jenkins, R, Wilson, PD, Binns, D, Thinley, P, Bulovic, N, Lemckert, F, Brassil, T and Reid, N (2022). NSW Forest Monitoring and Improvement Program. Project 2: Baselines, Drivers and Trends for Species Occupancy and Distribution. Report to the Natural Resources Commission.

4   Annual check of the evidence base

A key adaptive management approach adopted for the PNF Monitoring Program is to conduct annual checks to ensure the evidence base, including maps, is up to date, identify emerging evidence from monitoring and research, and opportunities for improvement.

The annual check considers multiple lines of evidence to identify:

- emerging evidence around private native forestry from monitoring, evaluation and research generated by the PNF Monitoring Program or from other sources
- opportunities for improving the PNF MER Framework, including changes to monitoring and evaluation priorities and data collection.

The Steering Committee, independently chaired by the Commission, has carried out the annual check of the evidence base, as required under Section 4.3 of the PNF codes and in accordance with the endorsed approach.[38] The 2023-2024 annual check is the second annual check conducted since the PNF codes were released in May 2022. The check focused on identifying new and emerging evidence from PNF MER and other sources. The identified adaptive management actions and gaps will inform current work to develop the implementation plan.

The Commission team hosted the annual check of the evidence base in August 2024 with LLS, EPA, DCCEEW and DPI, and three of the independent experts from the Steering Committee. In total, 36 sources of evidence were identified, including 15 PNF specific sources (the remainder provide broad forest contextual information). A summary of the evidence and actions arising from the annual check of the evidence base is presented in **Table 5**.

The 2023-24 annual check identified one gap in the evidence base. There is limited data or evidence on water pollution risks from PNF roads and tracks in forested landscapes. However, annual check workshop participants recognised that there are potentially transferable learnings or evidence from existing research and investigations that have occurred as part of the (former) cross-tenure NSW Forest Monitoring Improvement Program or the Coastal IFOA monitoring program on state forests. Targeted consideration of these evidence sources will support better understanding water pollution risks that may be associated with PNF roads and tracks in forested landscapes.

All new sources of evidence identified through the annual check are added to the stocktake of the evidence base to ensure it is up to date. This stocktake collates the identified evidence from the late 1990s to the present.

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[38]   Natural Resources Commission (2023) *Private Native Forestry Monitoring, Evaluation and Reporting – Approach for the annual check of evidence*. Prepared on behalf of the NSW Forest Monitoring Steering Committee.

Table 5: Summary of annual check actions

Evidence sources	Adaptive management – actions arising
PNF Plan and Forest Management Plan areas and number approved[39] Summary of landholder self-reported harvest areas and volumes	Data and emerging trends to be reported in the PNF MER Annual Progress Report Future annual check submissions from LLS to include information on the proportion of PNF Plan approvals that are new approvals or re-approvals of existing plans that have expired
Compliance activities undertaken by the EPA[40] Land and Environment Court decision on a PNF related prosecution[41]	LLS and EPA to identify opportunities for advice and support services provided by LLS to support PNF Plan holders to better understand their obligations or to flag matters relating to conditions for consideration as part of the formal five-yearly assessment process
Preliminary analysis from acoustic fauna surveys in north coast private native forests	Report the preliminary results in the PNF MER Annual Progress Report
Remote sensing of NSW private native forests – options and feasibility	Consider this report in subsequent stages of the remote sensing feasibility study for PNF MER and development of the PNF MER implementation plan
Estimating the extent of selective timber harvesting in private native eucalypt forests with multi-temporal lidar (Hislop et al 2024)[42]	Consider this journal paper in the remote sensing feasibility study and when developing the PNF MER implementation plan Discuss results in the PNF MER Annual Progress Report
2021 NSW Vegetation Clearing Report 2018 - 2021[43]	Consider the estimates of canopy disturbance related to private native forestry for use in the PNF MER implementation plan and include in the PNF MER Annual Progress Report
Private Forestry Guidance Materials (four reports from Forest & Wood Products Australia)[44]	Consider the useful of this information in day-to-day advice and support services for the Farm Forestry initiative or other programs (LLS) as well as more general contextual information on private native forestry in Australia
NSW Biodiversity Outlook Report 2024[45]	Consider this evidence when developing the PNF MER implementation plan and discuss findings in the PNF MER Annual Progress Report as they relate to broad forest context
DCCEEW mapping updates (plant community types[46] and state vegetation type map[47])	Consider if updates are relevant to any PNF code matters that relate to PCT or threatened ecological community mapping

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[39]   LLS (n.d.) Monitoring, Evaluation and Reporting.
[40]   EPA (2024) Native forestry compliance update.
[41]   Environment Protection Authority v Green [2024] NSWLEC 81.
[42]   Hislop, S., Stone, C., Samuel, J., Kathuria, A., Alaibakhsh, M., & Nguyen, T. H. (2023). Estimating the extent of selective timber harvesting in private native eucalypt forests with multi-temporal lidar. *Australian Forestry*, 86(3–4), 152–160. https://doi.org/10.1080/00049158.2023.2288776
[43]   NSW DCCEEW (2024) 2021 NSW Vegetation Clearing Report.
[44]   FWPA (2024) Private Forestry Guidance Materials (i) An introduction to the business of small-scale forestry; (ii) Private Native Forestry; (iii) Farm Forestry; (iv) Indigenous owned and managed forests.
[45]   DCCEEW (2024) NSW biodiversity outlook report 2024 Status and trends of biodiversity and ecological integrity.
[46]   DCCEEW (2023) Updating BioNet plant community types PCT master list C2.0.
[47]   DCCEEW (2023) NSW State Vegetation Type Map technical notes 2023 Release C2.0M2.0.

Evidence sources	Adaptive management – actions arising
Final determinations made by the NSW Threatened Species Scientific Committee in 2023-24 (36 flora and 14 fauna) [48]	Consider if determinations are relevant to any PNF code matters that relate to threatened species
Additional contextual material: Coastal IFOA monitoring program publications: injuries to retained trees, [49] perpetuating trees with hollows [50] Australia's State of the Forests Report 2023 [51] Journal publications – fifteen papers identified (**Appendix 1**)	Consider landscape scale contextual information in the PNF MER implementation plan, when analysing monitoring data and during the five-year formal assessment Add to stocktake of evidence base

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[48]   DCCEEW (2024) NSW Threatened Species Scientific Committee – Determinations. Webpage accessed 7 October 2024.

[49]   Western Sydney University (2023) Coastal IFOA Monitoring Program: Review of the impact of injuries to retained trees during forestry operations conducted under the Coastal IFOA in New South Wales – Final Report. Report prepared for the NSW Natural Resources Commission.

[50]   Gibbons, P. (2024) Perpetuating trees with hollows under the Coastal Integrated Forestry Operations Approval (IFOA) Report on a pilot study for the Coffs Harbour Timber Zone. Report prepared for the NSW Natural Resources Commission.

[51]   ABARES (2023) https://www.agriculture.gov.au/abares/forestsaustralia/sofr#current-data-and-information-reported-by-indicator

5   Priority next steps

5.1   MER implementation

The Commission is working with LLS to support finalising the implementation plan following the conclusion of the remote sensing feasibility study. When biophysical indicators have been agreed, LLS will commence data collection subject to available funds.

LLS will commence new MER activities outlined in the implementation plan, with oversight from the Steering Committee, as well as continue research and investigations already underway (for example acoustic monitoring of vocal fauna species in north coast private forests).

The Steering Committee, independently chaired by the Commission, will continue its oversight responsibilities including to conduct the next annual check of the evidence base for the 2024-25 year.

5.2   Finalise koala habitat modelling and prepare a revised draft PNF koala prescription map

The Commission will continue to work closely with independent experts and DCCEEW scientists and modellers to progress updates to the species distribution models underpinning the PNF koala prescription map. This will include evaluating model performance using independent vegetation survey data. Following this, a draft updated map will be prepared by DCCEEW, and the technical review team and experts will consider implications. The Steering Committee will then consider findings, and if warranted, propose map updates to the relevant Ministers.

Updates to the PNF koala prescription map must be overseen by the Forest Monitoring Steering Committee and require the joint approval of the Minister administering the *Local Land Services Act 2013* and the Minister administering the *Biodiversity Conservation Act 2016*.

5.3   Risk assessment to inform if further mitigations are warranted

Following endorsement of the risk assessment for key species listed in Appendix A of the PNF codes, the Commission team with input from the technical review team and advice from independent experts will consider whether further mitigation options or complementary measures are needed for at risk species.

The Steering Committee will then consider the findings and recommendations. These could include proposing amendments to protections for species in the PNF codes if material risks have been identified.

Appendix 1: Papers identified in 2023-24 annual check of evidence

Gibbons, P., Stojanovic, D., Lindenmayer, D.B. and Owens, G., 2024. Impacts of changing fire regimes on hollow-bearing trees in south-eastern Australia. *International Journal of Wildland Fire*, 33(2).

Hislop, S., Stone, C., Samuel, J., Kathuria, A., Alaibakhsh, M. and Nguyen, T.H., 2023. Estimating the extent of selective timber harvesting in private native eucalypt forests with multi-temporal lidar. *Australian Forestry*, 86(3-4), pp.152-160.

Huettermann, S., Jones, S., Soto-Berelov, M. and Hislop, S., 2023. Using Landsat time series and bi-temporal GEDI to compare spectral and structural vegetation responses after fire. *International Journal of Applied Earth Observation and Geoinformation*, 122, p.103403.

Huettermann, S., Jones, S., Soto-Berelov, M. and Hislop, S., 2023. Exploring the Influence of Forest Tenure and Protection Status on Post-Fire Recovery in Southeast Australia. *Forests*, 14(6), p.1098.

Law, B., Gonsalves, L., Brassil, T. and Kerr, I., 2024. Broad-scale acoustic monitoring of koala populations suggests metapopulation stability, but varying bellow rate, in the face of major disturbances and climate extremes. *Ecology and Evolution*, 14(5), p.e11351.

Law, B., Gonsalves, L., Slade, C., Brassil, T. and Flanagan, C., 2024. GPS tracking reveals koalas Phascolarctos cinereus use mosaics of different forest ages after environmentally regulated timber harvesting. *Austral Ecology*, 49(4), p.e13518.

McLean, D. and Goldingay, R., 2024. Response of medium-sized mammals in subtropical forests following Australian 'Black Summer' wildfires. *Forest Ecology and Management*, 562, p.121952.

Mitchell, M.K., Rendall, A.R., Lefoe, M.J. and Whisson, D.A., 2023. Food tree selection by an arboreal marsupial: Implications for timber harvest. *Forest Ecology and Management*, 544, p.121218.

Nyman, P., Shelley, J.J., Raadik, T.A., Lyon, J.P., Noske, P.J., Lane, P.N.J., Freeman, M. and Fitzpatrick, B., 2023. *Assessment of buffer width effectiveness for limiting connectivity between timber harvesting areas and streams: Protecting aquatic environments*. Arthur Rylah Institute for Environmental Research Technical Report Series, (370).

Taylor, R., Marshall, A.G., Crimp, S., Cary, G.J., Harris, S. and Sauvage, S., 2023. Associations between Australian climate drivers and extreme weekly fire danger. *International Journal of Wildland Fire*, 33(1).

Wagner, B., Baker, P.J. and Nitschke, C.R., 2024. How an unprecedented wildfire shaped tree hollow occurrence and abundance—implications for arboreal fauna. *Fire Ecology*, 20(1), p.42.

Wang, A., Zhao, Q., Yu, Z., Yu, J., Liu, Y., Wang, P., Zhang, G., Zhou, J. and Ding, S., 2023. Factors and thresholds determining sediment delivery pathways between forest road and stream in mountainous watershed. *Catena*, 224, p.106976.

Ward, M., Ashman, K., Lindenmayer, D.B., Legge, S., Kindler, G., Cadman, T., Fletcher, R., Whiterod, N., Lintermans, M., Zylstra, P. and Stewart, R., 2024. Shifting baselines clarify the impact of contemporary logging on forest-dependent threatened species. *Conservation Science and Practice*, p.e13185.

Wittwer, G. and Waschik, R., 2021. Estimating the economic impacts of the 2017–2019 drought and 2019–2020 bushfires on regional NSW and the rest of Australia. *Australian Journal of Agricultural and Resource Economics*, 65(4), pp.918-936.

Yu, J., Zhao, Q., Yu, Z., Liu, Y. and Ding, S., 2024. A Review of the Sediment Production and Transport Processes of Forest Road Erosion. *Forests*, 15(3), p.454.