CIFOA Monitoring Program - Evaluation of species and habitat survey and modelling

Final Report

Synthesis of evaluation outputs

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Report to the NSW Natural Resources Commission

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Front page photograph: Surveying for Hastings River Mouse. Image captured using white flash - large eyes, roman nose and white feet? (image: B Law)

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Executive Summary

- The current coastal IFOA (CIFOA) was the result of a comprehensive review of previous Integrated Forest Operations Approvals (IFOAs) that led to a landscape-based approach with more emphasis on monitoring (State of New South Wales and Environment Protection Authority, 2014). The CIFOA, however, still requires pre-harvest surveys for some species and habitat features using specified protocols and these were the focus of this evaluation.

- This evaluation forms part of the CIFOA monitoring program, required under Chapter 8 of the CIFOA conditions and Protocol 38.3 of the CIFOA protocols. It considered the appropriateness, effectiveness and efficiency of the pre-harvest species and habitat surveys, and associated models and record-keeping. The relevant CIFOA outcome statement is - *Environment features, habitat and risks are identified to ensure that protections and management actions are implemented to mitigate the impact of the forestry operation* (Chapter 4, Division 1 of the CIFOA conditions). Specifically, this evaluation aimed to address the following two high-level key evaluation questions:

1. 'Are the species and habitat survey and modelling conditions and practices effective in identifying the presence and location of native species and habitats in the area covered by the CIFOA?'
2. 'Do the species and habitat survey and modelling conditions and practices contribute to ensuring that protections and management actions are implemented to reduce the impact of the forestry operation?'

   Other parts of the CIFOA monitoring program evaluate the success of management actions.

- A mixed method design was used in the evaluation using document review, surveys, semi-structured interviews, and independent expert evaluation. Key evaluation questions provided a focus for the evaluation and were important for drawing conclusions from the information gathered. The evaluation questions yielded answers that enabled determinations about appropriateness, effectiveness and efficiency of the surveys, models, and record-keeping practices. Information gathered through each of the methods has been presented in four Interim Reports (Munks et al., 2022b, Munks and Bell, 2023, Proud et al., 2023, Bell and Munks, 2023). A synthesis of the evaluation outputs is provided in this Final Report.

- In answer to Question 1. Overall, we found that the CIFOA species and habitat surveys and associated models were reasonably effective in identifying the presence of the focal species and associated habitat features. The methods used were generally appropriate and were implemented through effective planning and field procedures. However, for some species the methods would benefit from review and improvement. Recommendations for improvement included updating the models, addressing the decline in database records, updating survey and modelling methodologies using new scientific information, exploring alternative technology and ways to improve survey efficiency, provision for specialist advice in the planning process, and providing further training and guidance material for practitioners. Species that need priority attention included Marbled Frogmouth, Albert's Lyrebird, Rufous Scrub-bird and *Philoria* spp. The outdated models which remain triggers for surveys for many species are of particular concern and their replacement with newer available updated models is considered a priority.

- In answer to Question 2. While there is room for improvement with many of the models and surveys, they do contribute to identifying the need for, and hence implementation of, protections and management actions at the site level. However, key general findings included the lack of follow-up monitoring and reporting of outcomes resulting in uncertainty around the effectiveness of some of the current practices and management actions in reducing the

potential impact of forestry operations. Other recently initiated parts of the CIFOA monitoring program should help with this. The fauna monitoring program began with a pilot in 2021 and officially started in 2022. The results will be used to assess the effectiveness of the protective measures delivered through the CIFOA in maintaining focal species. Initiation of this major part of the monitoring program is considered an important step forward in the overall approach to fauna management through the CIFOA and should result in improved information on the status of multiple species.

- The conservation requirements of species where the pre-harvest surveys and species-specific protection are inherently inefficient, and/or their occurrence is largely outside the state forest estate, might be better catered for through a Species Management Plan approach (eg., Hastings River Mouse, Northern Corroboree Frog, Rufous Scrub-bird, Marbled Frogmouth). This would include more emphasis on a precautionary approach to maintenance of habitat, where there is a risk associated with forestry practices, and follow-up trend and effectiveness monitoring.

- Other general recommendations based on the evaluation findings include:
    - develop additional guidance material agreed by all key stakeholders.
    - undertake periodic scientific updates covering new information on the ecology of the species, new survey techniques and management requirements.
    - monitor and report annually on the implementation and outcomes of the pre-harvest surveys to assist in assessment of the effectiveness of survey conditions and protocols.
    - undertake post-harvest cross-tenure, multi-jurisdictional monitoring to inform the overall effectiveness of pre-harvest surveys in contributing to meeting conservation management objectives.
    - undertake research projects to address key questions such as species' detectability, to inform review and improvement of survey protocols.
    - develop a CIFOA condition to enable adaptation to new scientific information in a timely fashion and to allow flexibility in decision-making to facilitate continual improvement.

- More specific recommendations for improvement are provided for each species, the models, record keeping and broad area habitat surveys. These cover habitat descriptions and modelling methods, survey methods, training, research, monitoring and alternative approaches.

- While this evaluation has resulted in many recommendations for improvements to the pre-harvest surveys and associated models, addressing these should not take emphasis and resources away from the broader monitoring component of the CIFOA. The need for more monitoring and reporting, to inform continual improvement of the conditions and protocols and increase awareness amongst the broader community, was raised by many who contributed to this evaluation.

Contents

1. Background

The Coastal Integrated Forest Operations Approval (CIFOA) (State of New South Wales and Environment Protection Authority, 2018) has the explicit ecological goal of maintaining the pre-harvest forest diversity of forest-dependent species, habitats and structural legacies in the harvested and regenerating stand. A comprehensive review of previous Integrated Forest Operations Approvals (IFOAs) resulted in the landscape-based approach delivered through the current CIFOA (State of New South Wales and Environment Protection Authority, 2014). This approach involves identifying and protecting forest features utilised by many different species at a range of spatial scales and more emphasis on monitoring rather than the inefficient preharvest surveys (Meek, 2004, Slade and Law, 2017). Initiation of the fauna monitoring program in 2022 is an important step forward in the overall approach to fauna management through the CIFOA and should result in improved information on the status of multiple species and the effectiveness of the landscape-scale protection measures (Natural Resource Commission, 2023). The CIFOA, however, still requires pre-harvest surveys for some species and habitat features using specified protocols and these are the focus of this evaluation.

The CIFOA has specific objectives in relation to threatened species conservation and biodiversity:

> *(a) to set out the minimum measures required to be implemented to protect **species**, communities and their **habitats** from the impacts of **forestry operations**;*
>
> *(b) to set out multi-scale protection measures that ensure sufficient and adequate **habitat** is provided at the site, **local landscape area**, and **management zone** scales; and*
>
> *(c) to set out measures for **species** or communities that require specific measures to ensure **habitat** is protected around known occurrences; (State of New South Wales and Environment Protection Authority, 2018)*

The conditions (State of New South Wales and Environment Protection Authority, 2018) set mandatory actions and controls which can only be amended by the Minister for the Environment and the Minister for Industry and Trade. An outcome statement explains the intent of each condition. The CIFOA protocols (State of NSW and Environment Protection Authority, 2020) provide additional enforceable actions to support implementation of the conditions. They can be adapted and amended by the EPA to ensure intended outcomes are delivered. Best practice guidance material may also be provided by the EPA (eg., Environment Protection Authority, 2020).

In relation to all conditions, the approval has the specific objective of ensuring the ongoing monitoring, evaluation, reporting and improvement of the approval so that it is effective in achieving the objectives of the approval and relevant outcome statements. The CIFOA monitoring, evaluation, research, and reporting are linked to decision making for policy and on-ground management of NSW forests. The overarching aim of the CIFOA monitoring program is to assess the effectiveness of the CIFOA mandatory actions (conditions and protocols) for protecting threatened plants and animals, habitats, soils, and water in achieving relevant objectives and outcomes (Natural Resources Commission, 2020b).

1.1. Evaluation purpose and high-level key questions

This evaluation forms part of the CIFOA monitoring program and is required under Chapter 8 of the CIFOA conditions and Protocol 38.3 of the CIFOA protocols (State of New South Wales and Environment Protection Authority, 2018, State of NSW and Environment Protection Authority, 2020). The questions addressed in this evaluation form part of the monitoring strategy titled ‘Independent evaluation of forestry practice’ (Natural Resources Commission, 2020a).

The CIFOA outcome statements and associated conditions (or required actions) specifically relevant to this evaluation are provided in Table 2 in the Evaluation Strategy (Munks et al., 2022a). The outcome statement for Chapter 4, Division 1 of the CIFOA conditions is the focus of this evaluation - ***Environment features, habitat and risks are identified to ensure that protections and management actions are implemented to mitigate the impact of the forestry operation.*** Other parts of the CIFOA monitoring program evaluate the success of management actions.

Protocol 20 referenced in Chapter 4 of the CIFOA conditions covers the required targeted species and habitat surveys conducted prior to the commencement of forestry operations. This protocol provides information on the methods that must be followed for the required survey and refers to Protocol 31 for listed species.

Specifically, this evaluation addresses the following two high-level key evaluation questions:

1. 'Are the species and habitat survey and modelling conditions and practices effective in identifying the presence and location of native species and habitats in the area covered by the CIFOA?'
2. 'Do the species and habitat survey and modelling conditions and practices contribute to ensuring that protections and management actions are implemented to reduce the impact of the forestry operation?'

When addressing these questions, consistent with the project brief (Appendix A), this evaluation focussed on -

- The effectiveness (including efficiency in terms of time) of the methods and approaches relating to species and habitat surveys (including the CIFOA protocols and conditions), including implementation
- The effectiveness of the species and habitat modelling, including the assumptions that underpin the models and implementation
- Data recording and record keeping (including reliability of data)

While the results of this evaluation may also be relevant to other CIFOA monitoring strategies (ie., monitoring key habitat features, monitoring species occupancy, species-specific monitoring – fauna, species-specific monitoring – flora) addressing the monitoring questions for these other strategies is beyond the scope of this evaluation.

1.2. Evaluation outputs

The results of the evaluation are provided in four interim reports (Munks et al., 2022b, Munks and Bell, 2023, Proud et al., 2023, Bell and Munks, 2023). This final report provides a synthesis of these outputs and an overall performance rating and rationale for each evaluation topic.

2. Evaluation Method

The background and details of the approach taken in this evaluation are covered in the Evaluation Strategy (Munks et al., 2022a).

A mixed method design was used in the evaluation using document review, surveys, semi-structured interviews, and independent expert evaluation. Key evaluation questions provided a focus for the evaluation and were important for drawing conclusions from the information gathered. The evaluation questions yielded answers that enabled determinations about appropriateness, effectiveness and efficiency (See Table 6 in Munks et al., 2022a) of the surveys, models and record-keeping practices. Multiple data sources were used to answer the evaluation questions. The data sources are provided in Table 3 in the Evaluation Strategy and in the Interim Reports (Munks et al., 2022b, Munks and Bell, 2023, Proud et al., 2023, Bell and Munks, 2023, Munks et al., 2022a).

While some components of the original evaluation strategy (Munks et al., 2022a) were adapted during the project, in particular the key questions, participants in the survey and interviews (due to availability) and the addition of a field visit to the FCNSW offices at Wauchope, NSW, the approach was generally implemented as planned.

2.1. Species Surveys and Broad Area Habitat Searches

The targeted species surveys and broad area habitat surveys, referred to in the CIFOA protocols, assessed in this evaluation are summarised in Table 1 and a summary of the current relevant conditions and protocols covering the required methodology are provided in Appendix C1 and C2.

Topics explored through key questions included:

Design - Uncertainty in the data/information used in the selection of a particular species or habitat survey approach, survey coverage, frequency, methods etc.

Training - Surveyor competency. The content, delivery and frequency of training courses and field days for those involved in implementation.

Communication - The degree to which the complex conditions and protocols are effectively communicated to practitioners.

Implementation - The degree to which surveys are implemented as required through the Coastal IFOA Conditions and Protocols, planning processes and procedures.

Meeting objectives and Demonstrated outcomes - The degree to which the surveys meet the objective and desired outcome. This included a consideration of adaptive management.

Value for money - An assessment of the efficiency of the approach in terms of time and money, degree of collaboration and outcome.

Strategic context - An assessment of whether the approach is appropriate considering the broader aims and goals of the CIFOA and associated environmental legislation.

Table 1. Summary of CIFOA species and habitat survey methods (for protocol details see Appendix C1 and C2).

Species	Modelled Habitat	Records	Method
Rufous Scrub-bird	Modelled habitat in an operational area	Record of Rufous Scrub-bird in or within two kilometres of the boundary of an operational area	Listening for calls in breeding season
Albert's Lyrebird	Where there is 10 hectares or more of Albert's Lyrebird modelled habitat in an operational area	Record of Albert's Lyrebird in or within two kilometres of the boundary of an operational area	Listening for calls and looking for nests
Marbled Frogmouth	10 hectares or more of Marbled Frogmouth modelled habitat in an operational area	Record of Marbled Frogmouth in or within two kilometres of the boundary of an operational area	Call broadcast
Assa darlingtoni (Southern metapopulation)	10 hectares or more of *Assa* modelled habitat in an operational area	2 km	Call broadcast
Philoria species	10 hectares or more of *Philoria* modelled habitat in an operational area	2 km	Call broadcast
Northern Corroboree Frog	In each operational area with Northern	N/A	Shout response

Species	Modelled Habitat	Records	Method
	Corroboree Frog modelled habitat in Bondo and Micalong State Forests		
Hastings River Mouse	10 hectares or more of Hastings River Mouse modelled habitat in an operational area	200 m	Microhabitat transect showing moderate to high suitability – then Elliot traps over 4 nights
Koala	Tallaganda, Badja, Dampier, Moruya, Wandella and Bodalla State Forests in the Southern Subregion; and (ii) Glenbog and Glen Allen State Forests in the Eden Subregion	Any local landscape areas in the Southern Subregion or Eden Subregion where a koala record occurs in or within two kilometres of the local landscape area in the last 10 years	Either Koala RGbSAT survey or a quality acoustic recording device survey All areas - Pre-harvest surveys, a visual inspection for Koalas immediately prior to a tree being felled
Large Forest Owls	The 'Large_Forest_Owl' spatial dataset shows forest owl exclusion zones which includes all modelled habitat for large forest owls	Record of a large forest owl species, being Powerful Owl, Masked Owl, Sooty Owl or Barking Owl, within an operational area which contains unassessed Crown-timber land or within two kilometres outside the boundary of the operational area which contains unassessed Crown-timber land	None identified
Flora species (various)	Potential habitat definitions are in Protocol 39 and DPE Species profiles.	All species, identified in the CIFOA protocols as requiring a protection measure, where there is a record within 5 km of the boundary of the operational area.	Targeted flora surveys are completed in areas identified as containing 'potential habitat' under Protocol 20.3(1). Where no potential habitat occurs, a minimum of 15-minute searches are required in an operational area in those locations where the most suitable habitat occurs, or the lack of habitat is to be documented.
Habitat Features	None identified	Known localities recorded on MapApp	Broad area habitat searches (BAHS) are undertaken as part of the pre-harvest mark up of an operational area and aim to identify habitat features or species prior to operational impacts.

2.2. Species and Habitat Models

Targeted fauna surveys through the CIFOA are based on the identification of potential habitat via habitat models (where available) and/or proximity to existing records. These models were evaluated by Proud et al. (2023), covering the adequacy of data and methods used for habitat models, whether the models were validated and whether spatial and temporal uncertainty is taken into account (eg., changes in climate and fire frequency/intensity). CIFOA models for specific species and their inputs were also compared with newer available habitat models, where possible.

2.3. Records and record-keeping practices

An important component of any survey is the recording and communication of results. Since the proximity to known records is used to prioritise pre-harvest targeted surveys (particularly flora) through the CIFOA, it is important that the accuracy and age of species and habitat features records, and how often such information is updated, is assessed.

The method used and information gathered in the evaluation of data capture methods and subsequent record keeping practices is provided in Bell and Munks (2023). This included assessment of the method of data recording, the time between collection of the data and entering into an accessible database, data validation procedures, the procedures and planning tools used to deliver the information to practitioners and policy makers to inform decision-making and whether there is an adequate 'Pathway to delivery', including any endorsement processes involved in data or 'planning-tool' release.

2.4. Synthesis of evaluation outputs

In this final synthesis the various outputs of the evaluation to date (ie., Munks et al., 2022b, Munks and Bell, 2023, Proud et al., 2023, Bell and Munks, 2023) were considered by the independent evaluation team and an overall performance and rationale was agreed on for each area and topic. A simple ranking style rubric (scoring guide) was used to guide decisions on a generic level of performance for each key evaluation question and hence each evaluation area (Appendix B). This ultimately provided answers to the high-level evaluation questions (2.1). The approach allowed integration of complex data and information through an inductive process. It allowed flexibility in decision-making and the incorporation of new information and understanding throughout the evaluation process.

The outcomes of the assessment of effectiveness, appropriateness and efficiency of species, taxa and habitat surveys are presented individually (Section 3.1). This includes a brief literature review of the relevant species ecology and survey methods. Large forest owls were not included in this section because a targeted survey is not required for these species under the CIFOA and evaluation of the strategic landscape approach for owls was beyond the scope of this project. However, since owls were covered to some degree in the online survey and structured interviews (Munks et al., 2022b, Munks and Bell, 2023), with regard to protocol 26.2, a brief summary comment and some recommendations are provided in this report (Section 3.5).

The outcomes for the broad area habitat searches, modelling and record-keeping evaluations are provided more generally in Sections 3.2, 3.3 and 3.4.

Recommendations for improvements to the targeted survey conditions and protocols are provided in Section 4.

3. Results and Discussion

3.1. Targeted Survey Evaluation

Table 2 provides the set of key evaluation questions (KEQs) for each of the topics covered in this part of the evaluation. A summary of the performance ratings agreed by the evaluators after consideration of all the information gathered (Munks et al., 2022b, Munks and Bell, 2023, Proud et al., 2023, Bell and Munks, 2023) is provided in Table 3. A brief review and rationale behind the ratings for each set of KEQs addressing the evaluation topics is provided in the sections below for each fauna species, and flora more generally.

Table 2 Key Evaluation Questions

Topic	Key questions
Design	To what extent are the surveys current best practice? Are the surveys appropriate in terms of survey effort and/or likelihood of detection? Are surveys conducted in the appropriate area? Is timing of surveys appropriate given timing of operations? Are surveys selected through a risk-based prioritisation process? Has there been adaptation of survey methods and prioritisation of species/habitats following major environmental change?
Training	To what extent is surveyor training adequate and appropriate? How competent are the surveyors? How effective is the training of surveyors? What improvements could be made to increase the effectiveness of the training?
Communication*	To what extent are CIFOA survey requirements communicated appropriately to practitioners through guidance documents or planning tools?
Implementation	How effective is the process for implementation of the surveys for this species? How effectively are the surveys applied through the required planning procedures? Are the surveys implemented effectively?
Meeting objectives and Demonstrated outcomes	How effective are the surveys in meeting the overarching objective and desired outcome? How reliable are desk-top assessments in detecting the occurrence of this species or its habitat at risk from a forestry operation? How effective have the surveys been in informing adaptive management?
Value for money	Are the surveys efficient in terms of time and cost? To what extent are opportunities for pooling of resources, collaboration with other organisations and networks taken up?
Strategic context	To what extent are the survey method and model for this species 'fit for purpose'? (eg., meet the requirements of the Coastal IFOA Conditions and Protocols and/or other relevant policy/legislative requirements)

*An additional question relating to communication to the broader community was also asked but this was considered 'out of scope' for the final ratings.

Table 3 Overall performance ratings for the CIFOA species and habitat surveys after consideration of multiple lines of evidence addressing the KEQs. (Note that 'Insufficient Information' means that there was not enough information to evaluate this topic). The rationale behind the ratings is provided in 3.1.1-3.1.9. A summary of key areas for improvement is provided in 4.1 and 4.3.

Evaluation Criterion (examples of topics covered by the key questions)*	SURVEY PERFORMANCE RATING									
	Hastings River Mouse	**Koala**	**Pouched Frog**	**Philoria spp.**	**Northern Corroboree Frog**	**Albert's Lyrebird**	**Rufous Scrub-bird**	**Marbled Frogmouth**	**Flora**	**BAHS**
DESIGN (Appropriateness - method, uncertainty, survey coverage, timing, frequency, adaptation and flexibility)	Moderately Appropriate	Moderately Appropriate	Moderately Appropriate	Minimally appropriate	Appropriate	Minimally Appropriate	Minimally Appropriate	Moderately Appropriate	Moderately Appropriate	Appropriate
TRAINING (Appropriateness - Surveyor competency, training content and delivery and effectiveness)	Appropriate	Appropriate	Moderately Appropriate	Minimally Appropriate	Moderately Appropriate	Minimally Appropriate	Moderately Appropriate	Moderately Appropriate	Moderately Appropriate	Moderately Appropriate
COMMUNICATION (Communication to practitioners)	Moderately Appropriate	Moderately Appropriate	Appropriate	Moderately Appropriate	Moderately Appropriate	Moderately Appropriate	Moderately Appropriate	Moderately Appropriate	Moderately Appropriate	Moderately Appropriate
IMPLEMENTATION (Process and procedures, on-ground)	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective

Evaluation Criterion (examples of topics covered by the key questions)*	SURVEY PERFORMANCE RATING									
	Hastings River Mouse	**Koala**	**Pouched Frog**	**Philoria spp.**	**Northern Corroboree Frog**	**Albert's Lyrebird**	**Rufous Scrub-bird**	**Marbled Frogmouth**	**Flora**	**BAHS**
MEETING OBJECTIVES and DEMONSTRATED OUTCOMES (Detection of species and habitats at risk, adaptive management)	Moderately effective	Moderately effective	Insufficient information	Insufficient information	Effective	Insufficient information	Moderately effective	Insufficient information	Moderately Effective	Insufficient information
EFFICIENCY - VALUE FOR MONEY (Time and cost, collaboration)	Moderately Efficient	Moderately Efficient	Minimally Efficient	Minimally Efficient	Efficient	Minimally Efficient	Minimally Efficient	Minimally Efficient	Moderately Efficient	Efficient
STRATEGIC CONTEXT (Are the surveys 'fit for purpose'?)	Moderately Appropriate	Moderately Appropriate	Moderately Appropriate	Minimally appropriate	Appropriate	Minimally Appropriate	Minimally Appropriate	Moderately Appropriate	Appropriate	Appropriate

*See Table 2

3.1.1 Hastings River Mouse, *Pseudomys oralis*

Background

The Hastings River Mouse *Pseudomys oralis,* found in NSW and Queensland, is currently listed as endangered under the NSW *Biodiversity Conservation Act 2016* and as Endangered under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (NSW Office of Environment and Heritage, 2022b). It is rare and patchily distributed throughout its range and is found in a wide range of topographic and habitat types, including areas disturbed through native forest harvesting and burnt regimes (Meek et al., 2003).

The current species profile summarises habitat for the species as -

'A variety of dry open forest types with dense, low ground cover and a diverse mixture of ferns, grass, sedges and herbs. Access to seepage zones, creeks and gullies is important, as is permanent shelter such as rocky outcrops and fallen logs. Nests may be in either gully areas or ridges and slopes. They eat seeds, leaves, insects and fungi. Home range size is generally between 0.5 ha and 4 ha and there may be some overlap with other individuals.'(NSW Office of Environment and Heritage, 2022b). The DPE profile provides a link to 20 vegetation classes in which the species has been found.

A habitat model was developed for the species in the mid-90s as part of the Regional Forest Agreement (RFA) to inform prioritisation of reserve areas (NSW NPWS, 2000, NSW NPWS, 1999). More accurate models have subsequently been developed using new records and more recent modelling techniques (eg., Law et al., 2014, Kavanagh et al., 2021) (for evaluation of models see Proud et al., 2023).

Forestry activities are included as a threat and management issue in the species' recovery plan (NSW Department of Environment and Conservation, 2005). Law et al. (2016), however, found that populations of Hastings River Mouse can recover rapidly after logging disturbance, provided some retention of habitat to enable recolonisation of logged sites is part of the management practice. They found a positive response to logging of moderate intensity and evidence that this was because the competitively dominant rats (*Rattus*) avoided areas regenerating after logging. These authors highlight the role of fire frequency and intensity as drivers of habitat suitability for this species at the landscape scale. They found little evidence to support the practice of excluding disturbance at sites with *P.oralis* and point out the importance of ensuring landscape heterogeneity for this species. The results of this work and ongoing monitoring of Hastings River Mouse inform the implementation and review of the CIFOA conditions and protocols relevant to this species.

Survey methods in the literature

Early survey guidelines for this species recommended trapping in areas of suitable habitat using 200 traps for 5 nights with modification according to the local conditions and availability of habitat (Tweedie and York, 1993). Trapping in a grid of 5 m between traps and traplines 20 m apart or trapping in a single line where habitat is linear (eg., riparian areas) is recommended. The guidelines recommend traps are placed in cover (eg., under ferns, overhangs, amongst rocks) and baited with peanut butter and oats. These guidelines stress the importance of collecting habitat information where the species is caught and where it is expected but not caught.

The 2005 Recovery Plan for Hastings River Mouse provides a method to identify potential habitat and trapping guidelines, derived from the threatened species licence prescriptions in the earlier IFOA for the upper north east and lower north east regions (Appendix 1 and 2 in NSW Department of Environment and Conservation, 2005). The habitat assessment method involves using the predicted range of the species, spatial information on vegetation types and topographic maps and aerial photography. Microhabitat surveys along 100 m transects are then recommended for every 10 ha of areas which contain: wet or dry sclerophyll forests with a grass, sedge or heath understorey; woodland

with a grassy, sedge or heath understorey; wet or dry sclerophyll forest or woodland with dispersed patches of sedge, grass or heath, or any of these vegetation types which support outcropping rock cover or boulder fields or have rock outcropping within 1 km. The procedure involves assessment of grass, sedge and rush cover, vegetation cover, heath cover and determining a shelter index. Values obtained are then compared with values provided in a recommended microhabitat prediction model (Smith and Quin, 1997) to obtain a score of microhabitat suitability for the species (unsuitable, moderate, high quality). The trapping guidelines in the Recovery Plan for the Hastings River Mouse recommend a minimum of 100 Elliot traps distributed in four transects (10 m intervals) over four nights per 50 ha of habitat, along with further details in relation to placement, type of bait, timing of surveys and handling of animals (NSW Department of Environment and Conservation, 2005).

Under the Saving our Species program the Hastings River Mouse has been allocated to the 'Landscape species management stream' because the species is distributed across relatively large areas and is subject to threatening processes that generally act at the landscape scale (e.g., habitat loss or degradation) rather than at distinct, definable locations. One of the actions recommended, supplementary to legislative and policy requirements, is to '*Conduct targeted survey for the species at sites where there has been little recent survey and where there has been no disturbance from fire, grazing or forestry for more than 30-50 years (e.g. Werrikimbe National Park, Timbarra, Gibraltar Range), to better understand long-term population persistence and response to disturbance, especially fire. Ensure that very high trap hygiene standards are maintained to avoid any bias due to trap avoidance. Incorporate into survey design the ability to evaluate any effects of competitive displacement by bush rats Rattus fuscipes.*'(NSW Office of Environment and Heritage, 2022j)

CIFOA survey requirements

The current integrated Forestry Operation Approval for the Coastal Region (CIFOA) requires targeted surveys for Hastings River Mouse in advance of forestry operations (Appendix C1). These involve intensive and extensive habitat surveys in areas planned for harvest where habitat is predicted or where a known record is nearby (eg., within 200 m) (Drury, 2022). Trapping for the species is then required within any areas of microhabitat that are found during the survey, at a rate of 25 Elliot traps per 25 ha, with a minimum effort of 50 traps, over four trap nights. Standard operating procedures with associated data recording guidelines have been developed to guide the implementation of this requirement (FCNSW, 2022). The CIFOA stipulates a 12 ha exclusion zone around any known records of the species (State of New South Wales and Environment Protection Authority, 2018).

Performance Ratings and Rationale for the KEQs

Design (Moderately appropriate)

While much of the information gathered (Munks et al., 2022b, Munks and Bell, 2023) supports the targeted survey approach for this species there are several areas that could be improved. The model for this species, currently used through the CIFOA, needs updating. The habitat description used in habitat assessments also needs review and updating, particularly considering recent environmental change. The design of trapping surveys (grid or transects) and ethical considerations in timing of trapping were also identified as areas for consideration in any review of the protocol.

Training (Appropriate)

The effectiveness of the surveys is closely related to the skill level of the surveyors in identifying the species. Most of the current surveyors have many years of experience and are skilled in training new surveyors. However, more formal training could be considered particularly in new technologies that may make surveys for this species more efficient and effective eg., detection dogs, eDNA methods, camera traps (Meek and Vernes, 2015).

Communication (Moderately appropriate)

While a draft SOP (FCNSW, 2022) has been developed for targeted species surveys, further guidance documents and planning tools (eg., identification guideline) would help with interpretation of the protocols for this species.

Implementation (Effective)

In general, the processes and procedures for implementation of the targeted survey protocols for this species were considered effective.

Meeting objectives and Demonstrated outcomes (Moderately effective)

There was evidence that the targeted survey method was considered effective in detecting this species. The moderate rating is because of the lack of evidence that the protocols are working in terms of minimising risk. A general finding was that further research is required into the effect of harvesting on this species and monitoring and review of the actions taken to reduce any impacts.

Although DPI Forest Science has undertaken research and monitoring to support the conditions and protocols for this species, the new information has resulted in few changes since the 1990s. The CIFOA would benefit from a condition that facilitated the timely revision of protocols in response to new information.

Value for money (Moderately efficient)

There was evidence that the targeted survey method was considered effective in detecting this species. However, it was generally considered time and resource intensive. Unpublished information provided to the evaluators reported that a total of 160,000 trap nights had been completed by FCNSW since 1997. Over 1000 trap lines, with on average 40 traps per trapline. The number of captures of Hastings River Mouse resulting from this trapping effort was not available but only 624 captures were reported from pre-harvest surveys and FCNSW research projects, combined, since 1984 (Drury, 2022). 6000 trap nights were reported as being completed following the drought and wildfires of 2019 resulting in only 6 captures of Hastings River Mouse. More recently, however, the number of captures has increased with additional monitoring and pre-harvest surveys. Alternative detection methods eg., detection dogs, eDNA methods, camera traps (Meek and Vernes, 2015) were suggested as ways to increase efficiency in terms of resources.

Strategic Context (Moderately appropriate)

Interviewees noted that the survey protocols for this species are an example of a compromise between regulatory and environmental requirements. The current CIFOA conditions and protocols for this species are considered more robust in the regulatory sense than the previous IFOA. A reduced requirement for pre-harvest surveys compared to the previous IFOA was dependant on increased monitoring which has only started recently. In effect, the effort for habitat assessments has increased while the trapping effort has remained the same.

A Species Management Plan, that delivers monitoring with repeat surveys and an updated model, was recommended as an alternative approach to the 'targeted survey and manage' approach, to improve effectiveness and efficiency. While a draft Species Management Plan for the Hastings River Mouse has been prepared there lacks a clear agreed process to inform consideration of such new initiatives in a timely fashion. This example documented in (Bell and Munks, 2023) illustrates the requirement for such a process (ie., a continual improvement process with timelines):

> "*Conservation management of Hastings River Mouse requires pre-operational surveys under Protocol 20 and the application of an exclusion zone for a record of the species associated with an operational area. The protocol for assessment of habitat suitability and the subsequent trapping requirements represents a substantial effort since required under the IFOAs. The effectiveness of this approach has not been assessed. There is substantial argument, including from part of the 'rodent' scientific*

community, that a Species Management Plan (SMP) involving repeat surveys and long-term monitoring could provide better conservation outcomes for Hastings River Mouse. To this end a SMP has been prepared for Hastings River Mouse. As the application of an exclusion zone for a record of Hastings River Mouse in or within 200 m of the boundary of an operation area is a condition under the CIFOA, the proposed change in approach to the management of this species to a Species Management Plan requires Ministerial sign-off. Consequently, considerable time may elapse before a change in the management approach can be realised."

3.1.2 Koala, *Phascolarctos cinereus*

Background

The koala *Phascolarctos cinereus* (Goldfuss 1817) is an iconic arboreal marsupial (DAWE, 2021a). It has a wide but patchy distribution across eastern and southern Australia (Martin and Handasyde, 1999). In New South Wales, koala populations are found on the central and north coasts, southern highlands, southern and northern tablelands, Blue Mountains, southern coastal forests, with some smaller populations on the plains west of the Great Dividing Range (NSW Office of Environment and Heritage, 2023a). The koala is closely associated with the distribution of trees of the genera *Eucalyptus, Corymbia* and *Angophora* on which it feeds (Marsh et al., 2021, Au et al., 2019, Moore and Foley, 2000). The size of koala populations varies greatly and home range size varies with the quality of habitat. Population decreases since European settlement, have resulted from the fur trade in the late 19th and early 20th century, habitat loss and fragmentation, drought, wildfire, disease, dog attack and roadkill (Melzer et al., 2000, McAlpine, 2015).

In 2012 the koala was listed as Vulnerable in New South Wales under the Commonwealth, *Environment Protection and Biodiversity Conservation Act 1999* and uplisted to Endangered in 2022, largely in response to the impacts of the 2019/20 bushfires. In 2022 the koala was also uplisted to Endangered under the NSW, *Biodiversity Conservation Act 2016*.

Studies have found that koalas can tolerate selective harvesting (Law et al., 2018, Kavanagh et al., 2007, Smith, 2004, Natural Resources Commission, 2022a). There is also some evidence that koalas are resilient to recent (up to a decade ago), heavy harvesting in north-east NSW, where a large proportion of the canopy is removed (Law et al., 2018, Natural Resources Commission, 2022a). Law et al. (2018) suggest that the high level of habitat retention at multiple spatial scales throughout State Forest contribute to this finding. Their results raised questions about the value of focussing retention only in koala 'high-use' areas, as identified through scat surveys, when compared to distributing koala browse trees in clumps across a planned harvest area.

Youngentob et al. (2021) note that while some changes in habitat quality for the koala are temporary, others can be long-term resulting in changes to the nutritional quality of a forested landscape for the koala. For example, areas of native forest in NSW and Victoria dominated by Silvertop Ash (*Eucalyptus sieberi*) following repeated fires and intensive harvesting in the past, are of low nutritional value for the koala. Such areas are thought unlikely to support koala populations into the future without widespread restoration with more palatable browse species (Au et al., 2019).

Future rising threats to koala populations include climate change related impacts. For example, a reduction in climatically suitable habitat has been predicted, with a significant eastward and southward contraction in the koala's range in Queensland, New South Wales and Victoria (Adams-Hosking et al., 2011). Fires are a direct impact, with at least 5000, and potentially many more, koalas dying in the 2019-2020 fires in NSW (Portfolio Committee No 7 Planning and Environment, 2020). Research and monitoring has found, however, that koala populations can recover after fire and that extinctions are unlikely where there is adequate connectivity of habitat and fire refugia (Natural Resources Commission, 2022b). Lunney et al. (2020) highlight the need for ongoing monitoring and

research to determine how koala populations change in relation to combinations of threats (eg., drought, fire, loss of habitat and fragmentation) and what management actions are needed.

Research by NSW DPI on the koala has been multi-faceted. It has developed new acoustic based surveys (Law et al., 2022, Law et al., 2018, Law et al., 2021) that are effective in detecting male koala bellows in the breeding season. The research includes regional scale occupancy surveys over hundreds of sites on both public and private land. This has been followed by site scale investigations using density estimates from acoustic arrays before and after timber harvesting and the black summer fires. GPS-tracking has provided detailed information on how individual animals use the forestry landscape. Ongoing monitoring of occupancy in north-east NSW is broadly tracking the status of the species over time. The results of this work inform the implementation and review of the CIFOA conditions and protocols relevant to this species.

Survey methods

Youngentob et al. (2021) reviewed current methods for assessing koala presence and abundance. They note that there is no single technique or widely accepted method to survey koalas and all methods have strengths and weaknesses. Their review found that use of multiple techniques and/or repeat surveys is desirable where there is a need to determine the presence/absence of koala in order to evaluate the potential impacts of major development projects. The benefits and limitations of the methods relevant to the current CIFOA targeted survey requirements are provided in Table 4.

Table 4 Benefits and limitations of methods to survey presence/absence of koalas relevant to this evaluation (adapted from Youngentob et al. (2021) who cites (Jiang et al., 2020, Phillips and Callaghan, 2011, Hagens et al., 2018, Law et al., 2018)

Method	Uses and Benefits	Limitations
Scats – SAT, RGB-SAT, or rapid-SAT	• Often used to establish koala presence and/or activity levels • Well-established methods that can be readily followed by personnel with basic training • Reduced time, cost and resources relative to some other search methods • Best suited for medium to high density populations	• Scat detectability can be low, producing many false negatives, particularly in low density populations • Search is limited to within 1 m of tree trunk, but scats may be deposited anywhere under the canopy • The strict search time does not allow for differences in detection rates between strata • Results are not necessarily comparable between sites due to differences in detectability • Surveys are usually targeted towards trees or habitats expected to be used by koalas, which generates a confirmation bias
Call playback	• Can determine whether there are any responding males in the vicinity of the call • Simple to undertake	• Can only be undertaken during breeding season • Only detects adult males who respond to the call • Potential to disrupt natural behaviour if the call is perceived as a threat • Probability of detection not known
Passive acoustics	• May be particularly useful for detecting koalas in low density populations • Little experience required for deployment • Additional data on the spatial arrangement of individuals can be obtained using carefully designed arrays	• Data can only be collected during breeding season • Primarily detects adult males who are actively bellowing • Requires post-collection processing using specialised software

Other points from (Youngentob et al., 2021) relevant to this evaluation:

- *Previous research has demonstrated that models of koala distribution cannot be generalised across regions (McAlpine et al., 2008). The habitat associations of koalas in one area are not necessarily consistent with the habitat associations of koalas in another area.*
- *Koala habitat maps and species distribution models can provide indicative information on areas that may be koala habitat. However, the information should not replace local field data and site observations. It is rare for maps to be fully ground-truthed and large-scale mapping is often limited in its ability to predict features at smaller scales that are important to landscape use by koalas. In addition, models and maps created with data from one area may lose predictive capabilities when applied to other areas.*
- *The likelihood of detecting koalas or scat is influenced by several environmental factors that are not consistent across landscapes or vegetation types, creating potential bias (Rhodes et al., 2011, Cristescu et al., 2012, Ellis et al., 2013). In particular, variation in scat detectability and decay rate can result in false positives and false negatives, and ultimately in inappropriate management decisions.*
- *Landscapes are heterogenous and even within these broader regions of future climate intolerance, there are likely to be refugia that allow the koala to persist in those regions for some time into the future. The availability of surface water may be an important ancillary habitat element of refugia in these areas. Given the potential for refugial koala populations to recolonise larger areas when conditions are suitable, identified climate refugia and wider areas of potential habitat that would provide connectivity between refugial populations will be particularly important to the persistence of koalas in the future, especially in the western part of the koala's range.*
- *Fire, as a disturbance event, can result in very high immediate mortality of koalas, but does not necessarily render a landscape uninhabitable to koala populations. Therefore, fire alone should not be a reason to discount areas that may otherwise be koala habitat. Many eucalypt species can resprout from epicormic buds under their bark and produce new leaves relatively quickly after fire (Burrows 2002).*
- *There are many widely used methods for assessing koala presence and abundance. It is important to recognise the limitations of each method to make appropriate inferences from the data. Some methods may be better suited than others to address specific questions or to use in certain environments. True absence cannot be demonstrated without repeated surveys across different seasons using multiple survey techniques.*

The koala is included in the 'Iconic Species' management stream under the NSW Saving our Species (SoS) program. A targeted management strategy has been developed with the aim of providing more habitat for the species, supporting local community actions, improving koala safety and health and generally building knowledge to inform koala conservation. The NSW Koala Strategy notes that more work is needed to identify the most appropriate method of surveying koala populations, including exploration of new technologies such as thermal detection of koalas using drones (DPE, 2022).

CIFOA requirements

Survey and management requirements for the koala have evolved over the life of the Forest Operation Approvals in NSW (Box 1). The current CIFOA requires targeted surveys for koalas for specified areas in the Southern or Eden subregions prior to the start of any forestry operation (Appendix C1, State of NSW and Environment Protection Authority, 2020). The survey methods stipulated are a Koala RGbSAT (regularised grid-based sampling design spot assessment technique) scat survey or an acoustic survey. The scat survey method involves surveying for scats (for two minutes minimum) at the base (within 100cm) of a minimum of 30 trees selected through a 1 km grid based design. Koala browse trees are prioritised in the sample. A variety of habitat variables are required to be recorded at each survey location including soil fertility and age of any faecal pellets found and any other indirect signs.

The acoustic surveys are required during the breeding season, using a recording device for a minimum of five nights, at sites every 100 ha and in the vicinity of a koala browse tree where they occur (Appendix B1, State of NSW and Environment Protection Authority, 2020).

Targeted surveys are currently not required for the northern regions covered by the CIFOA (State of NSW and Environment Protection Authority, 2020) (Box 1). In these areas management actions are determined according to the predicted occurrence of koala habitat through application of the koala browse prescription model (Koala_Browse_Tree_Prescriptions' *spatial dataset*) (see model evaluation in Proud et al., 2023).

Box 1. Evolution of Koala Survey and Protection Requirements under IFOAs *1998 – 2018*

North Coast of NSW

Koala management in the northern IFOAs (Lower north east and Upper north east) during this period was based on searching for individuals (sightings, call recordings, and pellets). Pre-harvest surveys also included call playback and spotlighting. Following detections, further searches (known as star searches) were undertaken to determine 'high-use' areas. Such areas were mapped and 20-metre exclusion zones implemented around them. Pellet searches were undertaken as part of all targeted traverses and during the mark-up searches. Any three consecutive trees with pellets underneath were triggers for a high-use area, if the star search determined more pellets under at least three out of any 10 trees. In addition, areas outside the high-use areas, and/or where two out of any 10 consecutive trees had pellets underneath, were deemed intermediate use.

Exclusion zones were established around high-use areas, including a 20-metre buffer and 10 trees retained per 2 hectares in compartments for high-use areas and 10 trees retained per 2 hectares in compartments where the intermediate use has been determined.

South Coast (Batemans Bay, Eden & Tumut)

The Eden IFOA varied with much more intense requirements with a record definition including records identified since 1980 and transects established at 50 to 100 metres apart across the proposed harvesting areas with pellet searches undertaken in 4 (50cm by 50cm) quadrats conducted at 25 or 50 metre intervals. Outcomes included: 50 m radius exclusions on trees with pellets, areas retained must be connected to nearest second order or higher stream order, old growth patches with links that are 40 metres wide, 150 hectares of suitable habitat for koalas must be retained within 1.5 km of the trees identified with evidence, 10 browse trees per hectare retained.

Overall assessment of the previous licence conditions for all regions concluded that approximately 400 hectares were identified and protected as high use areas, which was below the estimated area expected from the surveys. This is despite staff highly trained in pellet identification. This highlights the cryptic nature of koalas and very likely underestimate of abundance.

2018 – present

The north coast conditions under the CIFOA have moved to a koala habitat model triggered tree retention without the need for pre-harvest surveys. Moderate modelled habitat areas require 5 trees per hectare retained with high habitat areas requiring 10 trees per hectare retained. In addition, all trees are required to be inspected before falling and if a koala is detected a temporary 25-metre radius exclusion is implemented until the individual moves away.

The south coast still requires pre-harvest surveys of either scat searches (spot assessment technique – single tree identified as centre point and 30 nearest neighbours of specified dbh are checked for scats) or deployment of sound recording devices. A site-specific biodiversity condition is required to be developed if a koala is detected.

(C. Slade, FCNSW, pers. comm.)

Performance Ratings and Rationale for the KEQs

Design (Moderately appropriate)

Reliable information on the likely presence and/or abundance of koalas is key to inform management decisions under the CIFOA. The conditions and protocols have evolved and have had extensive expert input over time. Findings from this evaluation, however, suggest that they could adapt further toward managing habitat regardless of confirmation of presence/absence of an individual.

The approach taken in the north coast region is appropriate for the current aim (i.e., to manage habitat for the species based on predicted occurrence). However, the current 'browse prescription model' needs review and improvement using new information on occurrence of food trees in CIFOA regions.

The approach taken in the south coast region needs review and improvement. As pointed out by Youngentob *et al.* (2021), koalas are a cryptic species and distinguishing between non-detection and true absence is problematic. In low density populations, where scat surveys are still required, survey conclusions may be strongly influenced by only a few missed observations. The current focus in the south is on retention of browse trees in high use areas identified from scat or acoustic surveys. Issues include:

1. Missing areas that may have supported koalas in the past
2. Browse tree list used for scat surveys needs updating with new information
3. False negatives with scat surveys
4. Problems with acoustic surveys

Data that is collected or interpreted without acknowledging survey method-specific limitations can lead to inaccurate estimates of koala abundance and habitat quality. Alternative survey methods (such as acoustic recorders, detection dogs, thermal cameras and drones) could be tested, to supplement the survey methods already used in pre-harvest surveys in this region. Modelling of likely presence of koalas using new information on occurrence of food trees in this region could be an improvement on the current scat and acoustic surveys.

Training and Communication (Appropriate/Moderately appropriate)

In general, the training and competence of surveyors was considered appropriate and effective. However, there would be a benefit in further training for contractors implementing Condition 75 and for surveyors, covering new information on habitat and alternative survey techniques.

Implementation (Effective)

In general, the processes and procedures for implementation of the targeted survey protocols for this species were considered effective by the evaluators, based on the information gathered during the field visit. However, responses received during the online survey and structured interviews indicated that the level of awareness by those outside FCNSW was poor and that there was 'insufficient information' for many of the participants to make comment on the effectiveness of implementation.

There is a clear need for more transparency around the effectiveness of the processes and procedures. This could be resolved by reporting on how many times surveys and tree retention prescriptions are triggered and the areas retained. This sort of information could be documented as part of 'implementation monitoring'.

Meeting objectives and Demonstrated outcomes (Moderately effective)

The moderate rating is predominantly because of the uncertainty around the approach taken in the south coast region in detecting habitats at risk and enabling adaptive management. There is evidence, however, that habitat identification and retention at multiple spatial scales elsewhere is meeting management objectives for this species (Law et al., 2018, Natural Resources Commission, 2022a).

Value for money (Moderately efficient)

The inefficiency of the current targeted survey protocols for the koala in the southern region was highlighted in the information gathered in this evaluation. Suggestions for improvement included - use of alternative survey methods (sound recorders, drones, thermal cameras, detection dogs), model

review and improvement (considering new information about feed trees) and more collaboration with others working on koala conservation management.

Strategic Context (Moderately appropriate)

This evaluation focused on the following outcome: *Environment features, habitat and risks are identified to ensure that protections and management actions are implemented to mitigate the impact of the forestry operation* (Chapter 4 Division 1 of the CIFOA Conditions).

The information gathered suggests that for the koala a flexible habitat-based approach, supplemented by targeted surveys using multiple methods, would probably be more appropriate in addressing this outcome than the 'one-size-fits-all survey and manage' approach currently required in the southern region.

There has been some adaptation of the approach over time, with a move away from basing management decisions on scat surveys in the northern region. However, management in the south is still dependant on identification of 'high use areas' through scat surveys despite the known unreliability of this method. Identification of areas that require management prescriptions (including additional retention) through determining habitat quality and the need for restoration may be a better approach in all regions, like the approach adopted in the Private Native Forestry (PNF) Codes. These codes use the *PNF Koala Prescription Map*. This map identifies areas of high koala habitat suitability on private land, and triggers tree retention rules for forestry activities. Up to date Koala browse tree lists are a key input into the modelling and mapping, and they also inform retention of browse trees. If such an approach was adopted through the CIFOA then the data collated in the NSW Koala Habitat Information Base (NSW DPIE, 2019) should be taken into account in continual improvement of the habitat mapping and browse tree list.

3.1.3 *Philoria* spp.

Background

Five *Philoria* species are considered under the CIFOA – *Philoria kundagungan, Philoria loveridgei, Philoria pughi, Philoria richmondensis* and *Philoria sphagnicolus*. All are listed as endangered under the NSW, *Biodiversity Conservation Act, 2016* apart from the Sphagnum Frog, *P. sphagnicolus* which is listed as vulnerable. The Mountain Frog, *P. kundagungan* has a very restricted range in north-east NSW (NSW Office of Environment and Heritage, 2022e). Two recently identified species that also occur in this area are *P. pughi* and *P. richmondensis* (Knowles et al., 2004, NSW Office of Environment and Heritage, 2022g, NSW Office of Environment and Heritage, 2022f). Loveridge's Frog, *P. loveridgei* also has a restricted range in north eastern NSW (NSW Office of Environment and Heritage, 2022c) whereas the Sphagnum Frog is reported to occur more extensively but in fragmented populations along the eastern escarpment of the great dividing range (NSW Office of Environment and Heritage, 2022k).

All *Philoria* species require high moisture levels. *Philoria kundagungan, P. loveridgei, P. pughi* and *P. richmondensis* are most common in headwaters, riparian areas, soaks, seeps, areas with surface moisture, in subtropical and temperate rainforest and wet eucalypt forest types. *Philoria sphagnicolus* habitat is reported to occur typically at high elevations in sphagnum moss beds or seepages on steep slopes in rainforest and wet eucalypt forest but also in wet coastal foothills. The specialist nature of the habitat of these species is illustrated by this description from the NSW scientific committee final determination for the endangered listing of the Mountain Frog, *P. kundagungan*:

"*The Mountain Frog is a habitat specialist associated with mountain streams. It inhabits boggy headwaters of streams and soaks in Antarctic Beech forests, rainforests and wet sclerophyll forests above altitudes of approximately 550 m (Cogger 2000; Knowles* et al. *2004). Individuals burrow into loose, moist soil or moss and sit in mossy cavities on stream banks. Breeding occurs from late August to mid-February. Males construct water-filled breeding chambers in the ground, into which jelly-*

encapsulated eggs are deposited in a foam mass (Knowles et al. *2004). Each egg contains sufficient yolk to nourish an embryo through to the juvenile stage, and like other species of* Philoria*, Mountain Frog tadpoles complete their entire development within these nests."*

A variety of threats to macro and micro habitat for *Philoria* species are described in the species' online profiles. These include threats where forestry is specifically mentioned such as:

- Reduction of moisture levels and reduced water quality from road-works, forestry activities, frequent burning associated with grazing management and trampling by domestic stock.
- Isolation of populations through clearing and forest fragmentation associated with agricultural and forestry practices.
- Reduction in canopy cover from logging operations resulting in changes to soil moisture and solar exposure.
- Reduction of moisture levels caused by logging opening up the forest and drying out the ground litter, and forest management which changes old-growth forest to young even-aged stands, causing substantial water loss.
- Degradation of habitat from forestry activities including timber harvesting, road construction and burning.
- Degradation of habitat due to changes in hydrological regimes and water quality from logging, roadworks and domestic stock.

Inappropriate fire regimes and changes to weather patterns due to climate change are recognised as a risk to *Philoria* species. Wildfire is specifically mentioned as a threat for the Mountain Frog, *Philoria kundagungan* –

'Severe wildfire following drought (both likely results of climate change) is shifting the climatic niche of the habitat such that it is no longer able to sustain the species, particularly at low elevation sites. It is considered likely that loss of leaf litter for shelter and soil moisture due to fire increases adult mortality (i.e., direct mortality or lag mortality through predation or lack of food) and kills tadpoles.'

Management activities recommended in the species' profiles to maintain habitat quality include exclusion of logging around breeding habitat. Monitoring is identified as a priority action for many of the species. For example, for the Mountain Frog – '*Monitor populations of frogs known to have become isolated by past clearing activities to ensure they remain viable and threats are identified and managed where required*' – along with development of EIA guidelines – '*Develop EIA guidelines that include information about the impacts of changes to the natural hydrology on the habitat and include mitigation measures that include buffer distances around known sites*'(NSW Office of Environment and Heritage, 2022k).

Survey methods

In 2009 the NSW, Department of Environment and Climate Change produced guidelines to assist in determining the presence of threatened frog species (DECC, 2009) (Table 5). The guidelines note that different species have different seasonal and daily patterns of activity based on their biology and local weather. The guidelines strongly recommend that advice is sought from an expert on the timing and interpretation of surveys.

A more recent review and guide for the survey of threatened frogs as part of biodiversity assessments, also describes methods to establish the presence of *Philoria* spp. in a particular location and to collect data on the area of suitable habitat (DPIE, 2020a). The guide states that targeted frog surveys must be undertaken by someone with knowledge and experience of frog ecology and good frog identification skills. Both aural-visual surveys and acoustic recorder surveys are recommended in potential habitat for the five *Philoria* spp. considered under the CIFOA (DPIE, 2020a). Potential habitat descriptions are detailed for each species (Table 5) (DPIE, 2020a).

CIFOA requirements

The CIFOA requires targeted surveys for the five *Philoria* species (Protocol 20.4(6)) where there is 10 ha or more of modelled habitat for the frogs or a known record in or within 2 km of the operational area (Appendix C1) (State of NSW and Environment Protection Authority, 2020). Where there is no modelled habitat the surveyor is required to survey areas identified as habitat in the DPE species profiles.

Aural surveys (with a call-playback component) are required at the rate of 10 minutes for each 50 ha, for a minimum of 30 minutes. Call broadcast must occur for at least 2 minutes with a 10-minute survey period unless the species is calling freely. The prescribed timing of surveys is between 1 August and 31 March, during periods of likely high calling activity.

The method required is the same for all the species and repeats are not required.

Table 5 Survey methods for threatened frog species from DPIE, 2020 survey guidelines and the earlier DECC, 2009 guidelines.

*From NSW BAM survey guidelines for threatened frogs (DPIE, 2020a)

Species	Habitat description*	Timing	Area/transect	Aural		Acoustic		Reference
				Effort	Repeat	Effort (days)	Repeat	
Philoria kundagungan	Areas with continually high moisture levels above elevations of 800 metres and is most common in subtropical and temperate rainforests. It is found in shallow burrows in mud, concealed by leaf litter or rocky scree, in the headwaters and along the edges of constantly flowing streams or around permanent soaks. Suitable breeding habitat consists of seeps and soaks in gullies or along streams and located in areas of native vegetation. Non-breeding habitat is native vegetation linked to the breeding site.	Sept-Jan	500m	480min	4	154	1x14days	(DPIE, 2020a)
		Sept-Feb (diurnal)	200 m/water body	Not provided	2	-	-	(DECC, 2009)
Philoria loveridgei	Areas of continually high moisture, being most common in subtropical and temperate rainforests. It is found in shallow burrows in soil, moss or in leaf litter at headwaters and along the edges of constantly flowing streams or around permanent soaks in highland forest; however, this species is less tied to headwater stream environments than the other *Philoria* species and is known to occur at lower elevations in the boggy margins of second and third order streams. It can also be found in artificial habitats	Oct-Jan	500 m	480 min	4	154	1x14 days	(DPIE, 2020a)
		Sept-Feb (diurnal)	200 m/water body	Not provided	2	-	-	(DECC, 2009)

Species	Habitat description*	Timing	Area/transect	Aural		Acoustic		Reference
				Effort	Repeat	Effort (days)	Repeat	
	created by road drainage systems and walking tracks. Suitable breeding habitat consists of seeps and soaks in gullies or along streams, located in areas of native vegetation. Non-breeding habitat is native vegetation within 50 metres of suitable breeding habitat.							
Philoria pughi	Areas of continually high moisture including seeps and soaks, located in subtropical and temperate rainforests and wet sclerophyll forest at high elevations (>800 metres altitude). It is found in shallow burrows in soil, moss or under leaf litter in headwaters, along the edges of constantly flowing streams, or around permanent soaks in highland forest. The species is also found in outcrops where water seeps from the rocks leaving a permanently wet environment. Suitable breeding habitat consists of seeps and soaks, typically in gullies or along streams, in areas of native vegetation. Non-breeding habitat is native vegetation located within 50 metres of suitable breeding habitat.	Sept-Jan	500 m	480 min	4	154	1x14 days	(DPIE, 2020a)
		Oct-Jan (diurnal)	200/waterbody	-	2	-	-	(DECC, 2009)
Philoria richmondensis	Areas of continually high moisture including seeps and soaks, located in subtropical and temperate rainforests. It is found in shallow burrows in soil, moss or in leaf litter in headwaters, along the edges of	Sept-Jan	500m	480 min	4	154d	1x14 days	(DPIE, 2020a)
		Oct-Dec (diurnal)	200 m/waterbody	-	2	-	-	(DECC, 2009)

Species	Habitat description*	Timing	Area/transect	Aural		Acoustic		Reference
				Effort	Repeat	Effort (days)	Repeat	
	constantly flowing streams, or around permanent soaks in highland forest. The species is also found in outcrops where water seeps from the rocks leaving a permanently wet environment. Suitable breeding habitat consists of seeps and soaks in gullies or along headwater streams in areas of native vegetation. Non-breeding habitat is native vegetation within 50 metres of suitable breeding habitat.							
Philoria sphagnicolus	Areas of continually high moisture including seeps and soaks, located in subtropical and temperate rainforests. It is found in shallow burrows in soil, moss or in leaf litter in headwaters, along the edges of constantly flowing streams, or around permanent soaks in highland forest. The species is also found in outcrops where water seeps from the rocks leaving a permanently wet environment. Suitable breeding habitat consists of seeps and soaks in gullies or along headwater streams in areas of native vegetation. Non-breeding habitat is native vegetation within 50 metres of suitable breeding habitat.	Aug-Jan	500 m	480 min	4	154	1x14 days	(DPIE, 2020a)
		Sept-Dec (diurnal)	200 m/water body	-	2	-	-	(DECC, 2009)
Assa darlingtoni	The species does not breed in free water. Suitable habitat consists of montane areas (usually >600 metres in altitude, however	Sept-Mar	1 ha of breeding habitat	120 min for 500 m transect	4	154	1x14 days	(DPIE, 2020a)

Species	Habitat description*	Timing	Area/transect	Aural		Acoustic		Reference
				Effort	Repeat	Effort (days)	Repeat	
	the species is known to occur at lower altitudes, to approximately 100 metres) within PCTs associated with the species. It typically prefers areas of moisture such as deep leaf litter and rocky scree slopes. Eggs are laid under damp leaf litter, logs, rocks or anywhere on the forest floor.	Oct-May (nocturnal)	200 m	Late afternoon-9pm	2	-	-	(DECC, 2009)
Northern Corroboree Frog, *Pseudophryne pengilleyi*	Suitable breeding habitat consists of pools and seepages in sphagnum bogs, wet heath, wet tussock grasslands and herbfields in low-lying depressions. Non-breeding habitat is suitable native vegetation within 200 metres of suitable breeding habitat.	Feb-Mar	500 m of suitable breeding habitat	480 min (including visual survey)	4	-	-	(DPIE, 2020a)
		Jan-Feb (daytime or early evening)	200 m/waterbody	-	2	-	-	(DECC, 2009)

Performance Ratings and Rationale for the KEQs

Design (Minimally appropriate)

A general finding from the information gathered was that the survey method detailed in the CIFOA for these species needs review. This was primarily due to the out-of-date habitat descriptions, the timing of the surveys, the degree of survey effort and the lack of focus on individual species (some are not rainforest specialists and have different habitat requirements). The models for the species are considered too coarse and survey repeats are recommended to increase detectability. Monitoring of known populations to assess the effectiveness of the management approach for these species was highlighted as a priority.

The protocols could be reviewed and updated considering the increasing threats, focussing on

- Timing of surveys,
- Changes needed following the wildfires,
- Survey effort - change to minimum of 15 min per 100 m (consider using survey protocol by DPE). A reference site is needed and repeats (i.e., minimum of three surveys to improve detection probability).

Training (Minimally appropriate)

This evaluation found that there is a need for more formal training by frog ecologists to improve the knowledge and skills of those undertaking the surveys and/or those responsible for 'in-house' training of field staff. Although knowledge of these species has increased, there has been no formal training in the ecology of the species for 20 years. This would help build links with the species specialists as well as increasing surveyor skill levels.

Communication (Moderately appropriate)

Easy to understand information about the survey protocols, survey effort and outcomes is not freely available. While the draft SOP (FCNSW, 2022) covers the protocols for these species, the protocols are difficult to understand. Additional guidance material is needed for surveyors because the need for a survey is not triggered very often, hence knowledge/experience is easily lost.

Implementation (Effective)

The evaluators found during the field visit that the processes and procedures were appropriate and that the surveys were implemented as required. Additional guidance material, however, could enhance the process.

Meeting objectives and Demonstrated outcomes (Insufficient information)

There was limited information available to address the key questions covering this topic. This is primarily because of lack of follow-up monitoring and reporting of outcomes.

Value for money (Minimally efficient)

The targeted survey method for these species was generally considered inefficient. Specialists consulted during the evaluation recommended the trialling of alternative survey methods and design to increase the efficiency and effectiveness of the surveys e.g., call playback surveys, stream transect surveys, multi-seasonal surveys, and repeating surveys at different times of the day.

Strategic Context (Minimally appropriate)

These species are highly restricted and highly threatened by climate change. While the landscape-scale habitat protection measures for seeps, soaks and first order streams applied through the CIFOA undoubtably contribute to the protection of these species the need to detect and protect breeding habitat remains.

Information gathered in this evaluation suggests that the approach for these species needs to be reviewed and updated considering the increasing threats. Monitoring of known populations in forestry areas is a priority to determine the effectiveness of landscape-scale habitat protection measures.

3.1.4 Pouched Frog, *Assa darlingtoni* (Southern population)

Background

The Pouched Frog, *Assa Darlingtoni* is a relict species with a patchy distribution in forest refugia, and restricted range. The species profile lists five isolated populations, three in north-east NSW and two in south-east Queensland (NSW Office of Environment and Heritage, 2022h). The Pouched Frog is listed as vulnerable under the NSW, *Biodiversity Conservation Act 2016*.

Habitat for this species is described as, 'cool, moist rainforest, including Antarctic Beech (*Nothofagus moorei*), or moist eucalypt forest in mountainous areas, mostly above 800 m but have been found as low as 300 m. They spend most of the time in damp leaf litter, or under rocks and rotten logs (NSW Office of Environment and Heritage, 2022h).

Timber harvesting, road clearing and fire are all considered to be threats to Pouched Frog, particularly for the microhabitat and refugia on which the species depends (NSW Office of Environment and Heritage, 2022h). Protection of habitat from burning, clearing and timber harvesting have been identified as actions to assist this species.

Survey methods

Survey methods for this species are provided in (DECC, 2009) and (DPIE, 2020a) (Table 5). Both survey guides stress that frog surveys must be undertaken by someone with knowledge and experience of frog ecology and good frog identification skills. Both aural-visual surveys and acoustic recorder surveys in potential habitat are recommended (Table 5)(DPIE, 2020a).

CIFOA requirements

The CIFOA requires targeted surveys for *Assa darlingtoni* (Protocol 20.4(5)) where there is 10 ha or more of modelled habitat for the species or a known record in or within 2 km of the operational area (Appendix B1) (State of NSW and Environment Protection Authority, 2020). Where there is no modelled habitat the surveyor is required to survey areas identified as habitat in the Office of Environment and Heritage species profile or as identified by any other relevant information, but seeking advice from a species specialist is not a requirement.

Aural surveys (with a call-playback component) are required at the rate of 10 minutes for each 50 ha, for a minimum of 30minutes. Call broadcast has to occur for at least 2 minutes with a 10-minute survey period, unless the species is calling freely. The prescribed timing of surveys is between 1 August and 31 March, during periods of likely high calling activity. Repeats are not required.

Performance Ratings and Rationale for the KEQs

Design (Moderately appropriate)

Based on the information gathered in this evaluation the survey protocols for Pouched Frog were considered appropriate provided they are implemented by a surveyor with knowledge of the species' ecology and identification, and a good understanding of the protocols. The habitat model for this species, however, is out of date and needs to be updated taking new records into account. Parts of the protocol wording caused confusion and specific areas that need review and clarification include the meaning of 'adjacent' and the habitat description. The habitat description is not consistent with the 'Saving our Species' habitat description. The wording of part (iv) and (v) of the protocol for this species also caused some confusion for those unfamiliar with the protocols. As it is currently worded it suggests a survey is required to meet (iv) and (v) even if no habitat is found. This requirement needs

revising to say only survey suitable habitat so that time is not wasted surveying 'non-habitat' during a traverse.

Gaps in the protocol for this species included a lack of inclusion of locality data in the prioritisation of habitat assessments and no requirement to record environmental conditions at the time of the survey (eg., temperature, rain). Information on environmental conditions at the time of the survey help in interpretation of the results and although these are usually recorded as part of the targeted species surveys and entered into the corporate database (Bell and Munks, 2023) they are not specifically required as part of the protocol. Optimal conditions to detect this species could also be stated in the protocols.

Training (Moderately appropriate)

There is a need for formal training by frog ecologists to enhance the knowledge and skills of those undertaking the surveys for Pouched Frog and/or those responsible for 'in-house' training of field staff. This would help build links with the species specialists as well as increasing skill levels.

Communication (Appropriate)

There is a draft SOP (FCNSW, 2022) for surveyors and good transfer of information between planners and surveyors. The DPE species profile and call identification guides could be added to the survey tools.

Implementation (Effective)

The processes and procedures for implementation of the survey protocols for this species are considered effective based on the information gathered during the field visit and interviews.

Meeting objectives and Demonstrated outcomes (Insufficient information)

There was limited information available to address the key questions for this topic. This is primarily because of lack of follow-up monitoring and reporting of outcomes.

Value for money (Minimally efficient)

The survey approach is considered inefficient in terms of time and cost, mainly because of the lack of adequate habitat modelling and the lack of clarity around the conditions and protocols. This means that the effectiveness of the surveys depends on experienced surveyors, preferably species specialists. The survey efficiency and effectiveness could be improved by stating the optimal conditions for surveys in the protocols or guidance documents, for example narrowing the survey season to September-January.

Alternative survey methods could be tested for detectability, accuracy, efficiency eg., detection dogs, eDNA and remote acoustic recording devices.

Strategic Context (Moderately appropriate)

While the survey requirements are generally considered appropriate and effective in identifying the presence of the species and ensuring protective measures are implemented, there has been no follow-up monitoring to enable assessment of the adequacy of the approach in meeting the conservation management objective.

3.1.5 Northern Corroboree Frog, *Pseudophryne pengilleyi*

Background

The Northern Corroboree Frog, *Pseudophryne pengilleyi* is a small frog species with distinctive yellow markings. It has a highly restricted distribution and is known from sites within three geographic areas in NSW. It is listed as vulnerable under the NSW, *Biodiversity Conservation Act 2016*. Breeding habitat for the species is associated with pools and seepages in sphagnum bogs, wet tussock grasslands and

wet heath and non-breeding habitat is found in forest, sub-alpine woodland and tall heath (NSW Office of Environment and Heritage, 2023b). Populations also occur in the pine plantations near Tumut.

A major cause of decline in the Northern Corroboree Frog is thought to be due to Chytrid fungus. Other potential and emerging threats include climate change, fire, weed invasion, impacts from feral animals, control burning and erosion from roads and tracks and sedimentation (NSW Office of Environment and Heritage, 2023b). Protection of habitat and control of weeds have been recommended as actions to assist this species. The Northern Corroboree Frog has been assigned to the 'site-managed' management stream under the Saving our Species program.

Survey methods

Survey methods for this species are provided in (DECC, 2009) and (DPIE, 2020a) (Table 5). Both survey guides stress that frog surveys must be undertaken by someone with knowledge and experience of frog ecology and good frog identification skills. Aural-visual surveys in potential habitat are recommended, with attention to the relatively narrow period of calling and breeding for this species (Table 5)(DPIE, 2020a).

CIFOA requirements

The CIFOA requires targeted surveys for Northern Corroboree Frog (Protocol 20.4(7)) in modelled habitat in Bondo and Micalong State Forests (Appendix B1) (State of NSW and Environment Protection Authority, 2020). The shout response technique is specified, with a shout every 5 m followed by 30s listening. Surveys are required during the day between 14 February – 15 March (Appendix C1).

Performance Ratings and Rationale for the KEQs

Design (Appropriate)

The survey approach for Northern Corroboree Frog was considered appropriate, provided the surveys continue to be done by those who are familiar with the species and the survey protocols. There is a high likelihood of misidentification of the call and habitat if an inexperienced person does these surveys.

Some suggested improvements include clarification with respect to habitat and the 'extent' of the survey area. The timing and frequency of the surveys need review to increase detectability and efficiency. Flexibility in timing could be allowed due to 'seasonal factors and climate-change related factors', based on expert advice.

Training (Moderately appropriate)

The effectiveness of the surveys is dependent on the level of experience of the surveyor. Regular field days by frog ecologists would help maintain the knowledge and skills of surveyors.

Communication (Moderately appropriate)

Guidance material supporting the protocol is limited.

Implementation (Effective)

The processes and procedures for implementation of the survey protocols for this species are considered effective based on the information gathered during the field visit and interviews.

Meeting objectives and Demonstrated outcomes (Effective)

This was rated 'effective' by the evaluators because feedback from the interviews and information gathered during the review indicated that forestry activities are not considered a major threat to the species. Further work is needed to quantify the impact of forestry activities on this frog and its habitat and assess the need for ongoing management.

Value for money (Efficient)

Overall, the approach is considered efficient by all involved. The collaborative approach taken with this species, with good relationships between FCNSW ecologists and species specialists, has helped the efficiency and effectiveness of the approach.

Strategic Context (Appropriate)

While the survey requirements are generally considered appropriate and effective in identifying the presence of the species and ensuring protective measures are implemented, the CIFOA requirements have not kept up with research on this species. A Species Management Plan approach might be more appropriate for this restricted range species with a risk-based approach to habitat management and monitoring of the effectiveness of protective actions.

3.1.6 Rufous Scrub-bird, *Atrichornis rufescens*

Background

Rufous Scrub-bird is restricted to high rainfall, high elevation areas of far south-eastern Queensland and north-eastern NSW (NSW Office of Environment and Heritage, 2022i). Birds forage for small invertebrates in the leaf-litter and other ground vegetation where there is a dense cover such as ecotones, forested watercourses, and wetlands (Garnett and Baker, 2021). Rufous Scrub-birds are readily detected by the frequent and loud call of male birds.

Rufous Scrub-bird is listed as vulnerable under the NSW, *Biodiversity Conservation Act 2016* and endangered under the Commonwealth, *Environment Protection and Biodiversity Conservation Act 1999* (NSW Office of Environment and Heritage, 2022i). The Action Plan for Australian Birds considers both the northern sub-species and the southern sub-species of Rufous Scrub-bird to be 'possibly endangered'. The 2019 fires probably reduced the size of an already small population of the Rufous Scrub-bird stressed by drought. More than 50% of the 1 x 1 km grid squares from which the Southern sub-species has been recorded since 1990 were burnt, mostly in the Hastings Range. The 2019 fires burnt 37% of all 1 x 1 km grid squares from which the Northern sub-species has been recorded since 1990. One sub-population is monitored regularly but the rest are visited rarely. The population size of both sub-species is probably half what it was a decade ago because of drought and fire. There have been no comprehensive on-ground surveys since the 2019 fires (Garnett and Baker, 2021).

The northern sub-species of Rufous Scrub-bird occurs between Mistake Range in Queensland and Gibraltar Range in northern NSW. The southern sub-species has a patchy distribution from Dorrigo to Barrington Tops. It was formerly found in lowlands but partially due to land clearance is now only in high rainfall areas > 600 m elevation in sub-tropical, warm temperate and cool temperate rainforests, and wet sclerophyll forests. Rufous Scrub-bird is known from the Barrington, Carrai Plateau, Chaelundi, Coffs Coast and Escarpment, Comboyne, Dalmorton, Macleay Hastings, Upper Manning, and Washpool subregions of the NSW North Coast IBRA; the Ebor Basalts and Northeast Forest Lands subregions of the New England Tableland IBRA; and the Scenic Rim subregion of the South Eastern Queensland IBRA, mainly in wet sclerophyll and rainforest vegetation types (NSW Office of Environment and Heritage, 2022i).

The two sub-species of Rufous Scrub-bird have substantially different calls (Stuart and O'Leary, 2019). Male calling peaks in the breeding season but they call throughout the year. Each male sings over an area of about 1 ha and good territories can remain empty for several years after a male disappears suggesting there are few floaters in the population (Stuart and O'Leary, 2019). Rufous Scrub-birds spend most of the time foraging in deep moist litter beneath a very dense layer of vegetation or in woody debris. They breed in early spring but are typically shy and cryptic. Dome shaped nests are constructed in dense vegetation, close to the ground. It can take several years following intense fire before habitat can again be suitable for the species (Stuart and Newman, 2018).

The key threats to Rufous Scrub-bird include local extinctions because many populations and sub-populations are small and isolated; habitat disturbance from forestry; wildfire in dry conditions

(refugia are scarce following wildfire); road and track works where the species is among dense roadside vegetation; high altitude sites affected by increased temperature from climate change and possibly by fox predation; and insufficient knowledge of populations (NSW Office of Environment and Heritage, 2022i).

Rufous Scrub-bird is allocated to the Landscape species management stream under the *Saving our Species* program. Key threats to landscape-managed species including fragmentation and degradation of habitat, and widespread pervasive factors such as impacts of climate change and disease, are principally managed through legislation, policy, and landscape program approaches. In NSW 94 % of the distribution of Rufous Scrub-bird occurs in formal reserves. Five management sites are currently proposed for the species including New England, Border Ranges, Gibraltar, Werrikimbe-Carrai and Gloucester Tops.

Survey methods

Ferrier (1984) determined detection rates of Rufous Scrub-birds by calls and identified variations in detection rates between sites and habitat types, and environmental variables such as humidity and wind strength. Variations in detection rates have also been observed in response to drought conditions (Newman et al., 2014). Data suggest low detectability in February and high detectability in September-October with the onset of the breeding season (Stuart and O'Leary, 2019, Andren, 2016). Several authors (eg., Newman and Stuart, 2011, Andren, 2016, Stuart, 2020, Stuart and Newman, 2018) have added significantly to the knowledge of detection rates of calling birds (Southern Rufous Scrub-bird) under different environmental conditions and at different times of the year.

The potential for automated acoustic monitoring devices to assist with surveys and monitoring for Rufous Scrub-bird has been demonstrated (Garnett and Baker, 2021) recognising that the use of call playback to detect the species has been noted as a possible impact on the species and Newman and Stuart (2011) found that call playback was ineffective to survey for the Southern Rufous Scrub-bird. Acoustic recording devices, assisted by call recognition software, is considered a viable alternative for surveying and monitoring of Rufous Scrub-bird. Passive acoustic monitoring avoids observer bias, allows more normal bird behaviour, and reduces time and effort in data collection, particularly at remote or hard to access sites (Stuart and O'Leary, 2019).

CIFOA requirements

The Integrated Forestry Operation Approval for the Coastal Region (CIFOA) requires pre-operational surveys for Rufous Scrub-bird where there is modelled habitat in the operational area or where there is a record within 2 km of the boundary of an operation area (State of NSW and Environment Protection Authority, 2020). Pre-operational surveys must be conducted in the base net area and within 100 m of the base net area, between August and February at the rate of 4 survey sites per 50 ha of Rufous Scrub-bird microhabitat in the base net area, with a minimum number of 4 survey sites where less than 50 ha of micro-habitat occurs in that area, and within or adjacent to areas of micro-habitat. At each survey site the survey must consist of listening for calls for a minimum period of 10 minutes, repeated on 2 different days.

If the survey cannot be carried out during the peak calling season (August to February) the survey must be conducted at a rate of 8 sites per 50 ha of Rufous Scrub-bird microhabitat in the base net area, with a minimum number of 8 survey sites where less than 50 ha of micro-habitat occurs in that area, and within or adjacent to areas of micro-habitat.

Rufous Scrub-bird microhabitat is defined as areas of rainforest and/or wet sclerophyll forest that are: $\geq$ 1 ha in size; and contain extremely dense cover between 2 and 50 cm above the ground; or moderate cover between 50 and 100 cm above the ground. The cover may consist of living or non-living plant material or both. These areas generally have a moist microclimate and abundant leaf litter.

A pre-operational survey for Rufous Scrub-bird must be conducted no greater than seven years prior to the commencement of the forestry operation, be carried out by a suitably qualified person, and carried out in, and within 100 m of the base net area of the operational area.

The CIFOA requires rigorous and consistent recording of surveys for Rufous Scrub-bird. A tracklog of the survey must be recorded. A record must be made of the person who conducted the survey; the date of the survey; the start and finish times of the survey; and a record of the results of the survey including any detections of Rufous Scrub-bird and habitat features.

A Rufous Scrub-bird record in or within 300 m of the boundary of the operational area requires the application of an exclusion zone (Category 1 ESA) that encompasses all micro-habitat within a 300 m radius of the record with a $\geq$ 20 m additional exclusion zone around the outer edge of the micro-habitat. If a pre-operational survey is not conducted an exclusion zone must be applied to encompass all Rufous Scrub-bird microhabitat in the operational area including an additional exclusion zone $\geq$ 20 m in width around the outer edge of the micro-habitat.

The field location of an ESA for Rufous Scrub-bird must be mapped as an ESRI feature record using a GNSS-enabled device or other device that can accurately map the location or boundary of the feature. A validated record of Rufous Scrub-bird must be provided by FCNSW to NSW BioNet as soon as practicable but no more than 3 months after the species has been detected.

Performance Ratings and Rationale

Design (Minimally appropriate)

The survey responses and interview comments revealed that there has been insufficient survey effort for Rufous Scrub-bird to provide evidence to support the current CIFOA survey protocols. While the CIFOA survey protocol may detect Rufous Scrub-birds, with a single call usually representing a single occupied territory, there is a high probability of a false negative. Detectability needs to be considered in interpretation of the survey results. The likely proximity of territories is also not considered. Available data indicates a minimum separation distance of about 200 m between territories. Therefore, if a Rufous Scrub-bird call is detected then it is highly likely there will be about 200 m to the next possible occupied territory. The survey protocol does not currently take this into account.

The Rufous Scrub-bird is highly detectable by calls and low-cost acoustic recording devices such as 'AudioMoths' could be used to significantly increase the number of sites and geographical coverage of recorders and thereby the detection rate.

Models that trigger the surveys for this species are outdated (see also 'Model Evaluation', section 4.4). The habitat models are informed by survey data and would clearly benefit from absence data. However, there are issues around absence data when the probability of detection associated with the current survey methodologies is not known. There are five mountain top refuges for Rufous Scrub-bird in NSW. Three of these are monitored and these are the locations where most of the records come from. The underlying data for modelling and triggering surveys for Rufous Scrub-bird is therefore flawed because of this bias. For example, the Gibraltar Range doesn't get surveyed so does not get included in modelling, and the Border Ranges is cut off at the Queensland-NSW border so does not get surveyed on the Queensland side.

Early models were Maxent models, which were appropriate, though there were problems with the data rather than the statistical methods. The Rufous Scrub-bird model is very basic with predictors being 'high elevation' and 'wet areas'. Modelling the two subspecies separately could help improve the habitat models, however, there are currently too few records to do this. The model could start with mountain tops and be refined within this area. However, this is fundamentally a rare species problem, where a better model, beyond the basic 'mountain top' model is out of reach until there is better data.

While the current habitat models may predict the likely occurrence of the species at the landscape scale, at a local scale habitat might be missed because there is no input from species specialists. The CIFOA is very prescriptive for auditory surveys and does not allow for specialist advice. The definition of Rufous Scrub-bird microhabitat is not applicable across the entire range of the species resulting in issues with habitat identification in some locations. In some areas suitable habitat would not be surveyed because it does not fit the current microhabitat definition. Habitat can also be very patchy and patchy habitat could be sub-optimal. There is a clear need for a review of the habitat definition and a mechanism to allow for specialist input.

Fire as a disturbance can destroy habitat and create habitat in the medium term. Consequently, it is recommended that Rufous Scrub-bird habitat is re-interpreted in the post-fire landscape. Rufous Scrub-bird occupancy is generally stable unless there is a disturbance. There are some records of 30 years of occupancy. The 2019 fire led to the loss of habitat and may have had a serious impact on the species. However, there is a dearth of information on the relative impact of wildfire and drought on Rufous Scrub-bird because the 2019 fire came on the heels of the drought.

Training (Moderately appropriate)

Comments received during the structured interviews suggested that there was room for improvement in this area since the Rufous Scrub-bird call has been misidentified in pre-harvest surveys. There is a need to raise the identification skills of surveyors and/or if calls were recorded in the field by acoustic recording devices (even a phone or tablet) then they could be confirmed by a species expert. A Rufous Scrub-bird call will likely be followed by another call providing the opportunity to record the call and have it subsequently confirmed by an expert.

Determining Rufous Scrub-bird micro-habitat is extremely difficult and additional guidance and training is required to assist surveyors.

Communication (Moderately appropriate)

A SOP (FCNSW, 2022), guidance documents and internal communication processes for surveyors cover the CIFOA survey requirements for this species. However, the results of surveys and habitat models are not transparent and accessible. Therefore, there is a low level of awareness and understanding regarding the conservation management of this species through the CIFOA.

Implementation (Effective)

There are excellent processes and procedures in place for the implementation of the CIFOA protocols for this species. Because of the difficulty in interpreting Rufous Scrub-bird micro habitat descriptions, it is usually considered easier to do a survey than not. However, the emphasis is on following the rules of the CIFOA, rather than using skill and expertise to interpret the requirement for and the approach to the survey. This can make implementation of the surveys ineffective in some situations.

Meeting objectives and Demonstrated outcomes (Moderately effective)

While the survey protocols may detect the Rufous Scrub-bird, there has been no assessment of the degree to which the surveys meet the overarching objective and desired outcome of the CIFOA. The results of targeted surveys are not accessible and transparent. Therefore, it is difficult to answer specific questions relating to effectiveness in meeting the desired outcome. Desk-top assessments are obviously problematic as covered above in ‘design’. Many participants in the interviews and online surveys noted that there is no condition in the CIFOA for adaptive management.

There is a clear need for effectiveness measures of both the surveys and the application of management prescriptions and exclusion zones. There are no measures of effectiveness of the exclusion zones for Rufous Scrub-bird. For example, ‘do Rufous Scrub-birds stay in 1 ha patches that they have been identified as occurring in when the pre-harvest surveys are undertaken’. While evaluation of the success of management actions is beyond the scope of this current evaluation the results may have implications for the review and continual improvement of the surveys.

Value for money (Minimally efficient)

There is a clear need to embrace new and emerging technologies, particularly acoustic monitoring to increase efficiency of the surveys. Rufous Scrub-bird habitat is often impenetrable, and surveys often involve driving rather than walking, making passive acoustic monitoring ideal for detection surveys. Call recognisers have already been developed for Rufous Scrub-bird.

FCNSW recognises the advantages of working with other organisations such as SOS and LLS and would be supportive of a collaborative SMP approach to assess the effectiveness of the current survey methodologies and protections for Rufous Scrub-bird (e.g., assessing the persistence of the Rufous Scrub-bird in ESAs following logging operations). Note that there are no current SOS projects for Rufous Scrub-bird on State Forest.

Strategic Context (Minimally appropriate)

The model is appropriate and useful at a broadscale to target surveys. However, the model is not appropriate at an operational area scale. The current survey method requires review. The microhabitat description is not applicable across the range of the species and requires review. However, it is noteworthy that 94% of the current known habitat for Rufous Scrub-bird is in formal reserves.

3.1.7 Albert's Lyrebird, *Menura alberti*

The distribution of Albert's Lyrebird is restricted to a small area of far south-eastern Queensland and north-eastern NSW. Birds are much more often heard than seen and are shy and wary, and difficult to approach. Albert's Lyrebirds typically occur singly or in pairs. Their loud, penetrating call is often interspersed with mimicry of other species. They mainly occur in the wettest rainforests or wet sclerophyll forests with a wet understorey, often of rainforest species. They typically nest on a rocky ledge, fissure in rocks and base of caves and cliffs (NSW Office of Environment and Heritage, 2022a).

Albert's Lyrebird is listed as vulnerable under the NSW, *Biodiversity Conservation Act 2016* and is not listed under the Commonwealth, *Environment Protection and Biodiversity Conservation Act 1999* (NSW Office of Environment and Heritage, 2022a). The Action Plan for Australian Birds considers Albert's Lyrebird to be 'least concern' given that most of its habitat is managed for conservation. There was some loss of habitat to 2019 fires but there is no ongoing loss of habitat expected. Outlying subpopulations at Tamborine Mountain and Blackwall Range were not impacted by the 2019 fires. The losses from the 2019 fires were mapped though there is no ongoing monitoring for the species (Garnett and Baker, 2021).

Albert's Lyrebird is known from the Burringbar-Conondale Ranges, Clarence Lowlands, Scenic Rim and Woodenbong sub-regions and predicted in the Sunshine Coast-Gold Coast Lowlands sub-region of the South Eastern Queensland IBRA. The species is associated with 55 vegetation types in NSW, mainly Rainforests and Wet Sclerophyll Forests (NSW Office of Environment and Heritage, 2022a)

Albert's Lyrebirds are typically found in gullies, along watercourses, and on the slopes and ridges of steep mountain ranges (Higgins, 2001). Higher densities of the species occur in association with a canopy of eucalypts compared with rainforest lacking eucalypts, and in wet sclerophyll forest with greater weights of litter and logs and slower rates of litter decomposition (NSW Office of Environment and Heritage, 2022a). Much of the species' habitat was cleared in the 19th century (Garnett and Baker, 2021).

In high quality habitat Albert's Lyrebirds forage up to major ridges though in mid-quality habitat they tend to forage only on the lower slopes and gullies. They do not forage in dry sclerophyll forest. They are ground dwelling and feed where there is a deep moist layer of leaf litter and fallen logs. Albert's Lyrebird's feed on invertebrates that live in soil and leaf litter. They are solitary and the males are territorial. Breeding occurs over winter with clutches between late May and mid-August. Females lay a single egg and do all the parental care (NSW Office of Environment and Heritage, 2022a).

The key threats to Albert's Lyrebird include historical and ongoing clearing of rainforest and wet eucalypt forest, and substantial fragmentation and isolation of remnant patches, for forestry and agriculture. Intensive management of forest, particularly the loss of wet sclerophyll forest habitat to plantations and damage to the canopy, understorey and ground layers of rainforest and wet sclerophyll forest habitat, reduces and sometimes eliminates the species. Densities of Albert's Lyrebirds are much lower in plantations than in habitat recovering from selective logging. Lantana invades logged and other damaged habitat which further reduces suitability of the habitat. Fire is also recognised as a potential threat in exceptionally dry years, as is the stochastic risks associated with a small, isolated population in the Blackwall Range. Other threats include damage to habitat by stock grazing, encroachment of urban and rural development, and climate change. Predation by Red Foxes and feral dogs and cats may be a minor threat (NSW Office of Environment and Heritage, 2022a).

A study by (Kavanagh and Stanton, 2005) suggested that Albert's Lyrebird was a species that was disadvantaged by logging, with emphasis on intensive logging. More recently (Pavlacky Jr et al., 2015) considered Albert's Lyrebird to be sensitive to logging, and deforestation to be more detrimental to the species than rainforest fragmentation. They suggested that conservation actions that retain a high stand basal area, promote unmodified landscape mosaics, and maintain moderate patch size near large rainforest tracts are likely to be the most effective strategies for managing rainforest bird communities. They recommended retaining >50% of the basal area for vulnerable species of rainforest bird communities as it may take >4 decades for selectively logged stands to become suitable for the most vulnerable species (Pavlacky Jr et al., 2015).

Albert's Lyrebird is allocated to the Landscape species management stream. Key threats to landscape-managed species including fragmentation and degradation of habitat, and widespread pervasive factors such as impacts of climate change and disease are principally managed through legislation, policy and broad program approaches in NSW. Three management sites are currently identified by the Saving *our Species* program for Alberts Lyrebird including Mount Nullum, Border Ranges Complex and Numinbah.

Survey methods

The CIFOA does not provide detailed guidance on the survey methodology for Albert's Lyrebird beyond the requirement for the survey to be at a rate of at least 15 minutes per 50 ha or part thereof (with a minimum survey effort of 1 hr), to be conducted in the early morning, giving attention to finding the location of nests, to be conducted no greater than seven years prior to the commencement of the forestry operation, and be carried out by a suitably qualified person.

Tweed Shire Council recently developed quite detailed survey guidelines for the 'Listening for Lyrebird Citizen Science Project' which includes the following guidance: May, June and July are the best months for survey as this is the breeding season when the birds are calling the most; start 10 minutes after sunrise for 1-2 hours, noting that most calling is in the first half hour; undertake a 15-minute listening period at each survey point as 15 minutes is usually enough time to detect all calling males in the area without double counting; best locations for survey are in well-developed and mature rainforest or wet sclerophyll forest with a rainforest understorey and linkages to other large patches of rainforest or extensive native forest is the best; repeat surveys over several days e.g., once a week over May, June and early July; undertake a minimum distance of 1 km between survey sites unless sites are clearly independent, such as across a ridgeline; use vantage points such as high points; and, avoid rain and strong wind which influence both calling behaviour and observer detectability (Charley, 2021).

CIFOA requirements

The Integrated Forestry Operation Approval for the Coastal Region (CIFOA) requires pre-operational surveys for Albert's Lyrebird where there is $\geq$ 10 ha of modelled habitat in the operational area or where there is a record within 2 km of the boundary of an operational area (Appendix C1). Pre-operational surveys must be conducted in the base net area and within 100 m of the base net area

and conducted in the early morning, giving attention to finding the location of nests. Surveys must be conducted with a minimum survey effort of one hour. Where there is modelled habitat in the base net area or within 100 m of the base net area, surveys must be conducted at the rate of 15 minutes per 50 ha or part thereof. If there is no modelled habitat in the base net area or within 100 m of the base net area, surveys must be conducted in, or adjacent to the vegetation formations, classes and types identified in the Alberts Lyrebird profile published by OEH or identified by other literature if more relevant information exists.

A pre-operational survey for Albert's Lyrebird must be conducted no greater than seven years prior to the commencement of the forestry operation, be carried out by a suitably qualified person, and carried out in, and within 100 m of the base net area of the operational area.

The CIFOA requires rigorous and consistent recording of surveys for Albert's Lyrebird. A tracklog of the survey must be recorded. A record must be made of the person who conducted the survey; the date of the survey; the start and finish times of the survey; a record of the results of the survey including any detections of Albert's Lyrebird and habitat features, such as a nest; and searches in and around impenetrable understorey areas. Given the cryptic nature of Albert's Lyrebird nests, flagging tape must be used to mark the site to ensure protection.

Albert's Lyrebird or a habitat feature associated with Albert's Lyrebird (e.g., nest) might also be detected during conduct of Broad area habitat searches (BAHS) required prior to a forestry operation or during the carrying out of forestry operations.

An Albert's Lyrebird record in or within 300 m of the boundary of the operational area requires the application of an exclusion zone (Category 1 ESA) and the record of a nest requires the application of a 100 m radius exclusion zone. A record of Albert's Lyrebird in, or within 300 m of the boundary of an operational area requires an exclusion zone of $\geq$ 20 m in width on both sides of class 1, and $\geq$ 30 m in width on both sides of class 2 classified drainage lines within 300 m of the record. If a pre-operational survey is not conducted and there is modelled habitat or an existing record in, or within 300 m of the boundary of the operational area, an exclusion zone within modelled habitat of $\geq$ 20 m in width on both sides of class 1 classified drainage lines in the compartment, and $\geq$ 30 m in width on both sides of class 2 classified drainage lines in the operational area, must be applied.

The field location of an ESA for Albert's Lyrebird must be mapped as an ESRI feature record using a GNSS-enabled device or other device that can accurately map the location or boundary of the feature. A validated record of Albert's Lyrebird must be provided by FCNSW to NSW BioNet as soon as practicable but no more than 3 months after the species has been detected.

Performance Ratings and Rationale

Design – Minimally appropriate

The survey methodology needs to be better detailed for consistency of survey effort. Giving attention to the identification on nests could detract from identification of occupied territory. The probability of detection using the current survey methodology needs to be assessed to determine the efficacy of current survey methodologies for protection of Albert's Lyrebird. Fifteen minutes per 50 ha of modelled habitat may be insufficient to achieve a high probability of detection if Alberts Lyrebird is present. Information gathered in this evaluation suggested at least 1 hr survey per 50 ha of modelled habitat would be more appropriate. Repeats are desirable as a one-off survey for Albert's Lyrebird may be insufficient to detect the species. The current protocol has no requirement for surveys at a particular time of the year when the detectability may be higher e.g., breeding season.

The habitat model used to trigger the surveys is currently out of date. This model requires updating to incorporate more recent location records and information on the species. Application of surveys in the appropriate area is a function of the accuracy of the model, the extent of systematic surveys, and the current records of the species. There is also a need to increase detectability of the survey method

by considering the use of emerging technologies such as passive acoustic monitoring, camera trapping and detection dogs. Further work is needed involving the collection of reference calls and development of recognisers for this cryptic threatened bird.

Adaptation of survey methods for Albert's Lyrebird did not occur after the major fire event.

Training - Minimally appropriate

Survey success depends on the experience of the surveyors. There is no specific training for survey of Albert's Lyrebird. Skills are developed through undertaking surveys and learning from experienced surveyors. There is a need for planning tools, and training in ecology and survey methodology for Albert's Lyrebird. Survey conditions and protocols in the CIFOA are open to interpretation. Experienced volunteers are generally not utilised in surveys for Albert's Lyrebird by FCNSW.

Communication – Moderately appropriate

A draft Standard Operating Procedure (SOP) (FCNSW, 2022), guidance documents and internal communication processes for surveyors cover the CIFOA survey requirements for this species. However, the results of surveys and habitat models are not transparent and accessible. Hence, there is a low level of awareness and understanding regarding the conservation management of this species through the CIFOA.

Implementation – Effective

Based on interviewee responses the evaluators found that there are excellent processes and procedures in place for the implementation of the CIFOA protocols for this species. However, documentation of the data that demonstrates this is limited.

Meeting objectives and Demonstrated outcomes – Insufficient information

There is a clear need for work on the effectiveness of the surveys for this species. While presence/absence data is recorded there is little additional information collected to assist with adaptation of the survey method and habitat modelling eg., habitat and environmental data associated with detection data. Feedback loops for adaptive management were recommended by interviewees.

Value for money – Minimally efficient

Surveys did not appear to be efficient in terms of time and cost. Interviewees made recommendations to consider emerging technologies including camera traps and acoustic recorders to increase species detectability. There appears to be opportunity for collaboration with other groups and agencies such as with DPE and PWS through the SOS program, and councils such as Tweed Shire through a citizen science project focused on Albert's Lyrebird.

Strategic Context – Minimally appropriate

The current survey method and model for this species are not considered 'fit for purpose' given the comments and feedback received in this evaluation. The model and records may not be sufficient to cover likely occurrence of the species. The model requires updating to take account of new information and improvements in habitat modelling. However, it is noteworthy that Albert's Lyrebird is associated with rainforest habitats, areas that are protected on State Forest, including the network of riparian and ridge and headwater corridors. State Forest also makes up only a small portion of the available habitat.

3.1.8 Marbled Frogmouth*, Podargus ocellatus*

Background

Marbled Frogmouth is the smallest of the frogmouths. There are two widely separated subspecies in Australia, one restricted to central-eastern Cape York Peninsula, the other restricted to south-eastern

Queensland and north-eastern NSW, between Gladstone and Lismore (NSW Office of Environment and Heritage, 2022d). Typical habitat of the Marbled Frogmouth is rainforest. Marbled Frogmouths are nocturnal birds, foraging mainly on large insects. They are most easily detected by their distinctive calls. The species has a loud bubbling, gobbling territorial call ending with a bill clap and a softer but diagnostic repeated 'koo-loo' contact call. The Marbled Frogmouth is listed as vulnerable under the NSW, *Biodiversity Conservation Act 2016* (NSW Office of Environment and Heritage, 2022d).

Marbled Frogmouths typically occur in subtropical rainforest, particularly in deep, wet, sheltered gullies along creeklines and often associated with Bangalow Palms or ferns. In NSW, the species is mainly found in moist, mesophyll vine forest. Less often, the species occurs in ecotones between rainforests and wet eucalypt forests, or occasionally in cool rainforest and higher elevation temperate rainforests (NSW Office of Environment and Heritage, 2022d).

Marble Frogmouth is a nocturnal species, active at night and roosting during the day. Birds are usually seen singly, and during the day, adopt a cryptic pose, like other frogmouths, disguised as a tree branch. Their diet is mainly large nocturnal insects. Marbled Frogmouths breed from around August to December (Beruldsen, 1997).

The key threats to Marbled Frogmouth include clearing, fragmentation and isolation of rainforest and associated wet eucalypt forests for agriculture and forestry. Opening of the canopy by timber harvesting promotes dense understorey growth, weeds invade following disturbance and habitat is isolated through frequent burning of connecting forest (NSW Office of Environment and Heritage, 2022d). Actions identified for conservation of the Marbled Frogmouth include protection of forest connecting areas of known habitat from frequent fire, fencing of known habitat to exclude stock, removal of weeds, protection of potential habitat from clearance and reconnection of patches of known habitat with wide corridors including streamside areas.

The Marbled Frogmouth is allocated to the 'Landscape species management stream' under the *Saving our Species* (SOS) program because of its wide distribution and landscape-scale threatening processes. In NSW 37% of the distribution of Marble Frogmouth occurs in formal reserves. Ten sites on private land in the Border Ranges have been identified by the SOS program to target conservation actions for the species.

Survey methods

Beruldsen (1997) observed that Marbled Frogmouths may respond silently to call playback by approaching the source of the broadcast calls and concluded that sighting may also be important in surveys for detecting the species. He noted that Marbled Frogmouths appear to call later in the evening than other nocturnal birds and that Tawny Frogmouth *Podargus strigoides* sometimes occurs in rainforest and appears to react aggressively towards the Marbled Frogmouth. These observations have implications on detection using call playback techniques, and surveys conducted in rainforest habitat marginal to habitat of the Tawny Frogmouth. Indeed, Beruldsen (1997) suggested that Tawny Frogmouths may deter Marbled Frogmouths from calling in overlapping habitat, and road construction through rainforest by forestry may bring the two species into interspecific competition. Some authors describe that during the breeding season Marbled Frogmouths always replied to call playback and they assumed absence from sites where there was no response. Others have found false negatives after detecting the species on second visits. All agree that Marbled Frogmouths can call at any time of the year. Beruldsen (1997) concluded that a lack of response to call playback cannot be taken as evidence of absence and that repeat surveys may be required to confirm absence or detect responding individuals that approach silently.

Standardised surveys for nocturnal birds usually incorporate a listening, call playback and stationary spotlighting component with at least two repeat surveys at a single site – even then some birds may be missed (Debus, 1995).

Fulton et al. (2020) calculated a 0.88 probability of detection for Marbled Frogmouth in a peri-urban patch of rainforest at Brisbane using a listening/call playback/spotlighting survey protocol, repeated in 8 months over a period of about a year. They found that unelicited calls were heard more often than elicited calls, suggesting that reliable but incomplete data may be gained from listening or simply recording bird calls rather than by seeking a response to the broadcast of calls. Nonetheless, if they had not broadcast calls, they would not have detected the Marbled Frogmouth during the spring. They concluded that passive acoustic monitoring could be useful for detection, may be less stressful on nocturnal birds and may increase probability of detection.

Smith and Hamley (2009) undertook call playback surveys over 3 years in the Conondale Ranges of south-eastern Queensland and found responses to call playback were similar across years but with variations that could be explained by rainfall and habituation. They found a short peak in response in August which was associated with the onset of breeding, a lull in September associated with egg laying and incubation, a peak from November to March associated with brooding, nestling development, fledging and dispersal, and then a lull during the cooler months of April to July, the non-breeding period. They recommended monitoring or survey for detection of the species is best undertaken from November to March. They undertook call playback on dry, windless nights, conducted on one night or over three nights, from one hour after dusk to midnight.

Jones and Smith (1997) identified that the 'koo-loo' calls show consistent individuality potentially allowing the detection of individuals during surveys. This was unequivocal between male and female calling, giving some possible application of passive acoustic monitoring to census of Marbled Frogmouths.

CIFOA requirements

The Integrated Forestry Operation Approval for the Coastal Region (CIFOA) requires pre-operational surveys for Marbled Frogmouth where there is 10 hectares or more of Marbled Frogmouth modelled habitat in an operational area or where there is a record in or within 2 km of the boundary of an operational area (Appendix C1, State of NSW and Environment Protection Authority, 2020). Pre-operational surveys for Marbled Frogmouth must be conducted in the base net area and within 100 metres of the base net area. Where there is modelled habitat in the base net area, or within 100 metres of the base net area, surveys must be conducted at the rate of one call playback site for each 100 hectares of modelled habitat in the base net area, with sites distributed across the modelled habitat in the base net area. Where less than 100 hectares of modelled habitat is present in that area, a minimum of one call playback site must be conducted. Where there is no modelled habitat in the base net area, or within 100 m of the base net area, call playback sites must be undertaken in/or adjacent to areas within the vegetation formations, classes and types identified in the relevant species profile published by the Office of Environment and Heritage or identified by other literature if more relevant information exists. Surveys must consist of at least five minutes of call broadcast of recorded Marbled Frogmouth calls and 10 minutes of listening at the same site.

A pre-operational survey for Marbled Frogmouth must be conducted no greater than seven years prior to the commencement of the forestry operation, be carried out by a suitably qualified person, and carried out in, and within 100 m of the base net area of the operational area.

The CIFOA requires rigorous and consistent recording of surveys for Marbled Frogmouth. A tracklog of the survey must be recorded. A record must be made of the person who conducted the survey; the date of the survey; the start and finish times of the survey; and a record of the results of the survey including any detections of Marbled Frogmouth and habitat features.

A Marbled Frogmouth record in or within 300 m of the boundary of the operational area requires the application of an exclusion zone (Category 1 ESA), of $\geq$ 20 m in width on both sides of class 1, and $\geq$ 30 m in width on both sides of class 2 classified drainage lines. If a pre-operational survey is not conducted and there is modelled habitat or an existing record in, or within 300 m of the boundary of the

operational area, an exclusion zone within modelled habitat of ≥ 20 m in width on both sides of class 1 classified drainage lines, and ≥ 30 m in width on both sides of class 2 classified drainage lines in the operational area, must be applied.

The field location of an ESA for Marbled Frogmouth must be mapped as an ESRI feature record using a GNSS-enabled device or other device that can accurately map the location or boundary of the feature. A validated record of Marbled Frogmouth must be provided by FCNSW to NSW BioNet as soon as practicable but no more than 3 months after the species has been detected.

Performance Ratings and Rationale

Design – Moderately appropriate

The survey methodology is generally appropriate. However, the CIFOA is very prescriptive for auditory surveys and does not allow for variations in survey locations and protocol, even when recommended by experienced ecologists. There were recommendations to embrace new survey technologies, particularly acoustic monitoring, to increase efficiency and effectiveness of surveys. The species is highly detectable by calls and low-cost acoustic recording devices could increase effort, number of sites sampled and geographical coverage of surveys.

The method assumes a high probability of detection and equal detectability throughout the year. Apparently, presence/absence data is collected with little additional information to guide adaptation of survey methodology and habitat modelling. Survey methodology may need to be better detailed for consistency of survey effort, including consideration of time of night, number of repeat surveys, season of the survey. There is a need to consider the experience of surveyors to guide adaptation of survey methods.

There is no evidence of adaptation of survey methodology following major fire.

The habitat model and locality records are triggers for the application of surveys. Application of surveys in the appropriate area is a function of the accuracy of the model, the extent of systematic surveys, and the current records of the species. The habitat model for this species requires updating to incorporate more recent location records and information on the species (see Section 4.4). Habitat models may assist with selection of survey sites at the landscape-scale. However, at a local scale habitat could be missed without input from species specialists. The habitat models are informed by survey data and would clearly benefit from absence data. However, there are issues around absence data when the probability of detection associated with the current survey methodologies has not been calculated.

Training – Moderately appropriate

More formal training in identification of habitat at the local scale would be beneficial.

Communication – Moderately appropriate

The CIFOA conditions and protocols provides guidance on the survey methodology for Marbled Frogmouth, though the documents are difficult to navigate. There is a draft Standard Operating Procedure (SOP) (FCNSW, 2022), guidance documents and internal communication processes that cover the CIFOA survey requirements for this species.

Survey requirements for the species are open to interpretation and there is limited additional guidance material for practitioners on survey planning and methodology.

Implementation – Effective

The FCNSW processes and procedures for implementation are excellent with protocols for this species covered in the standard operating procedures (Sops).

Meeting objectives and Demonstrated outcomes – Insufficient information

It is difficult to assess the effectiveness of the surveys in meeting the objective for this species because the results of surveys are not transparent and accessible. There is a need for testing the effectiveness of both the surveys and the application of management prescriptions and exclusion zones for Marbled Frogmouth. This could be assisted by the recording of additional environmental information associated with a record. There is no condition in the CIFOA for adaptive management.

Value for money - Minimally efficient

The CIFOA is very prescriptive for auditory surveys for the species and does not provide for variation in the survey locations and the protocol, even when recommended by experienced ecologists. The use of acoustic monitoring (provided appropriate recognisers and automation of analysis can be achieved) may reduce time and cost and increase detection of the species. FCNSW recognises the advantages of working with other organisations such as SOS and LLS and would be supportive of a collaborative species management plan (SMP) approach to assess the effectiveness of the current survey methodologies and protections for Marbled Frogmouth.

Strategic Context – Moderately appropriate

While the survey requirements are generally considered appropriate in identifying the presence of the species and ensuring protective measures are implemented, the CIFOA requirements have not kept up with research on this species. Habitat models require updating to incorporate recent records and information on the species – currently useful at a broadscale but not at an operational area level. The habitat models would benefit from absence data, so detectability needs further exploration. A Species Management Plan approach might be more appropriate for this species with a risk-based approach to habitat management and monitoring of the effectiveness of protective actions. However, it is noteworthy that Marbled Frogmouth is associated with rainforest habitats, areas that are protected on State Forest, including the network of riparian and ridge and headwater corridors. State Forest also makes up only a small portion of the available habitat.

3.1.9 Flora

Background

Surveying for multiple threatened flora species (both predicted and non-predicted) in large areas of potential habitat is a complex task requiring considerable knowledge and experience of the surveyors, and the use of survey techniques that are appropriate to the taxa likely to be present. Detectability of threatened flora will reflect both these factors. Important considerations include seasonal and temporal constraints, the detectability of species across vegetation and habitat types, and topography.

For the purposes of the CIFOA, threatened flora and endangered populations have been grouped, in part, according to the application of generic management prescriptions including flora considered to be adequately protected by the approval (10), flora that require a 20-meter exclusion zone around all individuals (85) or flora that require protection for mature individuals or populations (12). The remaining threatened flora and endangered populations are grouped according to the requirement for a species management plan (SMP) (7), a flora road management plan (FRMP) (17) or still require the development of site-specific biodiversity conditions (14).

The identification or record of a threatened flora species or endangered population not covered by a site-specific condition under the CIFOA, within 100 m of an operational area, requires the development and approval of a site-specific biodiversity condition. A forestry operation must not commence, or must cease if already underway, and cannot commence or recommence until a site-specific condition is approved, or an authorisation is provided by the EPA.

The SOS species profiles provide descriptions of the habitat of threatened flora species and endangered populations, as well as descriptions of the broad distribution, and maps of known and

predicted distribution by IBRA subregion (now automatically updated in BioNet) and known vegetation associations. These and other relevant taxa specific publications and documents are used to determine the habitat types for targeted flora surveys (DPIE, 2020b).

Survey methods

The CIFOA does not provide species-specific guidance on the survey methodology for pre-operational surveys for flora species. However, for all flora species listed in Part 3 and Part 4 of Protocol 31 (approximately 135 species and endangered populations), a traverse is required to be conducted, searching at a maximum speed of 1 km per hour, within the identified survey season and within potential habitat for the species, in or within 20 m of the operational area (State of NSW and Environment Protection Authority, 2020).

Site-specific measures are implemented which aim to mitigate the impact of forestry on flora species and their habitat, and to support their persistence. Pre-operational surveys are required for flora species listed in the tables in Part 3 (Flora species and endangered populations protected by the application of a species-specific condition) and Part 4 (Threatened species requiring development of site-specific biodiversity conditions) of Protocol 31, where there is a record within 5 km of the boundary of the operational area. *Rhizanthella slateri* (species) and *R. slateri* (endangered population) are exempt from this condition.

A pre-operational survey for flora species must be conducted no greater than seven years prior to the commencement of the forestry operation and be carried out by a suitably qualified person.

Flora species may also be incidentally detected during conduct of 'Broad area habitat searches' (BAHS) required prior to a forestry operation, or during the conduct of forestry operations (Appendix C1, C2).

Prior to commencing a pre-operational flora species survey FCNSW is required to document each flora species requiring a survey, record the apparent location and extent of potential habitat and document the relevant survey season for each of the species.

A pre-operational survey for a flora species must consist of a traverse searching at a maximum speed of 1 km per hour; be undertaken in the survey season identified in Protocol 31; be undertaken in potential habitat for the species in or within 20 m of the operational area; be a minimum of a 1 km traverse when potential habitat for one or more species includes areas up to 10 ha; and, include an additional 350 m of traverse for each additional 10 ha of potential habitat. Pre-operational surveys for flora species are not required more than 20 m inside the boundary of an existing ESA. Where there is a record of a species in or within 20 m of the operational area, including a record made after the pre-operational survey, a minimum 10-minute additional effort must be undertaken in the surrounding area of potential habitat.

Where areas of potential habitat for a flora species are not identified FCNSW must document why the operational area does not have the capacity to support the species and hence, why the survey is not required; or undertake a minimum of 15 minutes searching in the most suitable habitat for the species.

Where there are areas of impenetrable understorey and a flora survey cannot be undertaken, a safe distance must be traversed, and a similar survey effort applied on the periphery that would have otherwise been applied within the area of impenetrable understorey.

The CIFOA requires rigorous and consistent recording of surveys for flora species. A tracklog of the survey must be recorded. A record must be made of the person who conducted the survey; including the date of the survey; the start and finish times of the survey; a record of the results of the survey including any detections of flora species; and searches in and around impenetrable understorey areas.

A flora species record in or within 20 m of the boundary of the operational area requires the application of an exclusion zone (Category 1 ESA). For flora species listed in Table 1, Part 3 of Protocol 31, a 20 m exclusion zone around all individuals is required; for species listed in Table 2, the protection

of mature individuals or populations is required; for species listed in Table 3, a species management plan (SMP) is required; and, for species listed in Table 4, a flora road management plan (FRMP) is required.

The field location of an ESA for a flora species must be mapped as an ESRI feature record using a GNSS-enabled device or other device that can accurately map the location or boundary of the feature. A validated record of a flora species must be provided by FCNSW to NSW BioNet as soon as practicable but no more than 3 months after the species has been detected.

A range of other exclusion zones required under the CIFOA are also likely to assist in minimising the impact of forestry operations on flora species, particularly for species associated with 'Heath and scrub', 'Rocky outcrops and cliffs', 'Threatened ecological communities', 'Wetlands' and 'Riparian exclusion zones for classified drainage features'.

Performance Ratings and Rationale

Design – Moderately appropriate

In general, the survey methods applied for flora are considered appropriate for the aim of the targeted surveys under the CIFOA – 'Flora' are identified to ensure that protections and management actions are implemented to mitigate the impact of the forestry operation. Most forest compartments have been systematically surveyed under previous approval conditions. Therefore, combined with the previous systematic surveys, the 5 km record trigger for a targeted pre-harvest flora survey is considered an adequate approach. Given the objective for pre-harvest surveys there is a need for targeted surveys where there is limited information and in areas that have not been previously surveyed.

The survey design is largely generic and reflects 'best practice' in a general sense. There are limited data to assess the appropriateness of the survey effort and the likelihood of detection on a species-specific basis. However, it is likely that for some species, survey effort and likelihood of detection are below what would be considered appropriate and for others, above what would be considered appropriate. The timing of surveys appears to be appropriate in terms of flowering time but other factors that influence species-specific presence do not appear to be considered (e.g., history of disturbance, drought, fires, flood, windthrow etc.). Presumably this is considered at the individual survey level but is not a specific requirement of the CIFOA.

Improvements that were suggested during this evaluation included targeting and adaptation of surveys to species that need it most. However, since multiple flora species surveys are often required it was acknowledged that this makes species-specific survey protocols difficult to apply.

Sensitivity of flora to logging needs additional review, research and monitoring. The CIFOA is tied primarily to threatened species. Some flora species are threatened by forestry activities because of specific life history traits. For example, weeds are one of the greatest threats to flora species in forestry. Flora species may benefit from broader management regimes that address the associated threats rather than, or in addition to, survey and management by exclusion zones or other avoidance protocols. There is potential for flora species habitat models to better focus pre-operational surveys.

Flowering times identified in the CIFOA can be too broad or too narrow leading to issues of detection during targeted flora surveys. For example, there can be difficulties in surveys for flora species which are not visible outside of their flowering season (e.g., orchids) or are otherwise ephemeral in occurrence.

Training – Moderately appropriate

There is a need to consider the experience of surveyors to guide adaptation of survey methods. There are several factors that influence detectability including the level of skill of surveyors and the

identification of potential habitat. There is currently no specialist training of surveyors for flora surveys.

Training and the skills of surveyors were considered reasonably adequate in the past. Each region has an ecology team. There are degrees of field experience which appear overall to be adequate. However, there is a need for more formal training such as the TAFE program (certificate course) and training in habitat surveys.

Threatened flora locations are progressively being identified by FCNSW as reference sites for field staff to visit and familiarise themselves with species identifications.

Communication –Moderately appropriate

Generic flora survey requirements and management prescriptions are appropriately articulated through the conditions and protocols. However, there is little guidance for practitioners on species-specific survey requirements and constraints, and management approaches. Interviewees indicated that the CIFOA was an improvement on previous conditions and protocols. However, practitioners would benefit from additional support through guidance documents and planning tools.

Implementation – Effective

Flora surveys appear to be implemented effectively. The process for implementation is reasonably clear. The detection of flora species is generally a function of the experience of the surveyor and the survey effort within the operational area. However, a generic survey approach for threatened flora is likely to leave some species over surveyed and others under surveyed.

The FCNSW processes and procedures for implementation are excellent with protocols for flora covered in the standard operating procedures (SOPs).

Meeting objectives and Demonstrated outcomes – Moderately effective

The overarching objective for flora in general under the CIFOA is not clear. There is a need to consider extinction risk such as the IUCN and threatened species listing criteria in the development of species-specific objectives and associated conditions. The adequacy of surveys for flora species to meet the objectives of the CIFOA is a species-specific question and making generalisations about the adequacy of such factors is inappropriate. The overarching objective for management of threatened flora is not clear. Many flora species are treated in a similar manner without explicit consideration of the likely impact and relative contribution to risk of extinction of forestry activities. Desk-top assessments are considered adequate in detecting general occurrences. However, interviewees suggested more targeted modelling and an adaptive approach is required.

Desktop assessments (i.e. known records of flora species) provide an indication of the general occurrences of flora species but do not assist with detecting flora populations that may occur in unusual locations.

Adaptive management is not pursued as strongly as is could be under the CIFOA. This may be due to resource constraints and practical considerations. There is a need for consideration of flora species records, collected by FCNSW as part of targeted species surveys and BAHSs, to have feedback loops for review of new information and subsequent review and revision of the requirements under the CIFOA protocols.

Value for money – Moderately efficient

Flora surveys are considered efficient against meeting the CIFOA requirements. They are less efficient in taking account of previous surveys, to inform the adequacy of current survey effort.

At a species-specific level, flora surveys can be onerous in terms of time and cost. While additional survey effort would increase detectability of a flora species, the current required survey effort is considered moderately efficient.

One example of inefficiency is the conservation management of *Drachophyllum macranthum*. This requires the application of a Flora Road Management Plan (FRMP). The species was delisted in February 2022, presumably recognising that forestry activities are no longer a threat to the species' viability. However, in February 2023 the requirements of the FRMP remain in place. This example demonstrates a level of inflexibility and/or protracted procedure associated with the relevant CIFOA conditions and protocols for flora species. The ongoing requirement for survey and management for this delisted species is considered to add unnecessary cost and is inefficient use of FCNSW's ecological staff and resources.

Strategic Context – appropriate

A 'one size fits all' approach to threatened flora survey, while generally fit for purpose, can fail some threatened species which are ecological outliers (e.g., species with highly patchy distributions, ephemeral species requiring environmental cues for germination or specific disturbance events such as fire or flood). The detection and management of threatened flora would benefit from improved habitat models as current descriptions of potential habitat are often quite broad. The trigger for survey may not capture some species that occur in unusual locations.

3.1.10 Overall performance ratings for the targeted surveys

Table 6 Key evaluation topic areas and performance ratings for targeted surveys in general.

KEQ	Performance rating
Design	Moderately appropriate
Training	Moderately appropriate and moderately effective
Communication	Moderately appropriate
Implementation	Effective
Meeting objectives and Demonstrated outcomes	Moderately effective/Insufficient information
Value for money	Minimally - Moderately efficient
Strategic Context	Moderately appropriate - Appropriate

Design- Moderately appropriate

While much of the information gathered in this evaluation indicated that there is support for the targeted 'survey and manage' approach through the CIFOA many aspects of the protocols require updating, considering new scientific information. In particular, the models and/or habitat descriptions used as triggers for the surveys need review and improvement. Several species would benefit from consideration of new and emerging survey techniques and a framework for adjusting survey techniques in response to new information. For example, the need to explore the use of passive acoustic monitoring for bird and frog surveys was mentioned many times in the information gathered. Participants recommended further research into application of these new techniques to improve the efficiency of the surveys, including development of call recognisers for acoustic monitoring.

An alternative risk-based approach to the management of habitat was proposed as a more effective and efficient approach for some of the species (eg., Hastings River Mouse and Northern Corroboree Frog, Marbled frogmouth). This would have an emphasis on monitoring rather than pre-harvest targeted surveys, expansion of monitoring sites and adoption of new models.

One element that appeared to be lacking in the current targeted survey conditions and protocols was scope for expert input into interpretation of the protocol. Access to species specialists for advice such as on habitat interpretation, timing of surveys, effort required for a particular site and conditions, and interpretation of the results, is important to increase the effectiveness and efficiency of the surveys in detecting the species. The current rigid design for most of the species' surveys, with little flexibility and consideration of local conditions, is not ideal.

Training- Moderately appropriate and Moderately effective

FCNSW have developed their own 'inhouse' training of field ecologists, in survey techniques and the identification of species and associated habitat features. The regional ecologists are responsible for training of field technical staff. The information gathered indicated that this 'on-the-job' training was appropriate with highly skilled staff involved in the surveys and training. Some species specialists who participated in this evaluation were concerned, however, about maintaining the competency of surveyors into the future and would prefer more input into the process. Further training by specialists

would be desirable, to maintain the efficiency and effectiveness of the surveys. This is particularly important for species that are surveyed rarely, where there is potential for identification skills of field staff to decline over time. Field days and training courses could be an opportunity to exchange information and experience between specialists and technical staff/surveyors, and generally increase confidence in the overall approach and enable exploration of alternative approaches.

Communication- Moderately appropriate

Planning tools and guidance documents to support interpretation of the conditions and protocols by planners and surveyors are limited. However, there was evidence that this is being addressed, through development of the draft SOP (FCNSW, 2022) and new guidance documents for some species.

Implementation-Effective

A key finding of this evaluation was that FCNSW allocate a considerable amount of time and resources to the implementation of the targeted survey protocols. The processes and procedures are followed to a high standard and result in the specified surveys conducted in the most likely habitat based on current available information.

Meeting objectives and Demonstrated outcomes- Minimally effective

The shortcomings of elements of the survey procedures for many of the species (eg., out of date habitat models and habitat descriptions) and the lack of monitoring and reporting of the outcomes made it difficult to evaluate whether the surveys are effective in meeting the overall objective (ie., detect the occurrence of the species, taxa, habitat in order to minimise the risk of forestry operations).

Value for money- Moderately efficient

This rating considers the two different perspectives, managers/surveyors vs species specialists. 'Are the surveys efficient in terms of cost to business?', versus, 'Are they efficient in terms of value for money in detecting the species?' For example, pre-harvest surveys are required for all flora species based on the presence of specified flora species records within 5 km of a harvest boundary, irrespective of whether they are covered by a road management plan or species management plan. This dual requirement is inefficient. The botanists and ecologists' overall perspective, however, was that the survey methods are efficient though species-specific survey effort is more difficult to quantify.

Strategic context- Minimally - Moderately appropriate

The overall goal of the CIFOA, for biodiversity, is to maintain the pre-harvest diversity of forest-dependent species, habitats and structural legacies in the harvested and regenerating stand. Forest features utilised by many different species are protected at a range of spatial scales with an emphasis on monitoring rather than preharvest surveys. Some preharvest surveys, however, are still required for some threatened species to inform decisions around what habitat to retain and where. These surveys are implemented according to the protocols. However, the information gathered in this evaluation raised questions about whether the outcomes of the surveys are contributing to the broader goal of the CIFOA. The inefficiency and undemonstrated effectiveness of some the pre-harvest surveys and species-specific protection measures and lack of monitoring and adaptive management in the highly prescriptive regulated CIFOA environment, was noted by many participants. These concerns may be addressed by the broad landscape-scale biodiversity monitoring program recently initiated across all state forests and the species-specific research and monitoring programs managed by FCNSW.

3.2. Broad area habitat search (BAHS)

The CIFOA aims to conserve a range of habitat features in different contexts and at multiple spatial scales (Condition 57, Protocol 20). The habitat features surveyed prior to operations are summarised

in Appendix C2. The broad area habitat searches are an important part of meeting the CIFOA objectives for biodiversity and are predominantly undertaken as part of the pre-harvest mark-up of a harvest coupe, although some features are picked up during the earlier targeted species surveys. The aim is to identify key habitat features pre-harvest in order to design and implement protective measures.

The set of key questions for each of the topics covered by the evaluation of the BAHS were similar to those used in the targeted survey evaluation (Table 2). A summary of the performance ratings for the BAHS agreed by the evaluators after consideration of all the information gathered (Munks et al., 2022b, Munks and Bell, 2023) is provided in Table 3. A brief review and rationale behind the ratings for each set of KEQs addressing the evaluation topics is provided in the text below.

Performance Ratings and Rationale

Design – Appropriate

Observations made during the field visit indicate that the surveys for habitat features are comprehensive, timely and cover the appropriate areas. All hollow bearing trees that are suitable as dens are retained and protected along with the addition of Wildlife habitat clumps tree protection clumps.

A key finding from comments received during the online survey and interviews, however, was that this condition would be enhanced by more specific guidance in the protocols around search effort and methods for the identification of some key habitat features (eg., owl nest, glider den). These habitat features may only rarely be detected and protected as species-specific features (eg, an owl nest hollow) under the current CIFOA conditions which currently rely on known localities of features identified in previous, more detailed, field surveys. A requirement for nocturnal surveys would be appropriate in some areas, to detect and protect new records, as diurnal surveys are ineffective at detecting these features.

Another key observation was lack of flexibility in identification of key habitat features at-risk from forestry activities and the option to seek expert advice on specific issues. The identification of habitat features during a BAHS would benefit from increased access to habitat specialists (external to FCNSW) to assist with species-specific issues and interpretation of the protocols.

Training – Moderately appropriate

The quality of broad area habitat searches is entirely dependent on the skill and diligence of those undertaking the task. This is potentially variable and the task of the surveyor needs to be valued and resourced to achieve the best results. Current training of field staff in habitat feature identification is delivered 'in-house' by FCNSW ecologists, covering BAHS methodology, context, habitat feature identification and data collection and recording. Participants complete a detailed assessment at a trial field site to demonstrate competency. Given the key role of the BAHS in meeting the CIFOA objectives for biodiversity and some threatened species (eg., owls and arboreals) this training would be enhanced by additional training and/or field days with species/taxa specialists. Such training should include all involved in the planning, implementation and compliance monitoring of the BAHS (eg., forestry technicians, ecologists, auditors, planners and managers) to ensure consistent understanding and identification of habitat features.

Communication – Moderately appropriate

While comprehensive Standard Operation Procedures (eg., FCNSW, 2021a) and guidance documents are available for surveyors to help with interpretation of the protocols for some habitat features, the lack of consistency with other available guidelines causes confusion and inefficiency. For example, the Hollow Tree Guidelines produced by FCNSW (FCNSW, 2021b) differ from those produced by the EPA (eg., EPA NSW, 2014, EPA NSW, 2020). This confusion needs to be addressed and more science-based

guidance material, appropriate for the purpose, is needed for other features (eg., giant trees, spotted tailed quoll dens etc.). Such material could be developed and endorsed by an independent scientific working group.

Implementation – Effective

This rating was derived largely from information gathered by the evaluators during the field visit. BAHS are a major part of the planning process ie., tactical planning, fauna and flora evaluation and targeted surveys, development and identification of ESAs, development of the harvest plan and prescriptions, broad area habitat searches, harvest area mark-up, harvest. The evaluators found that this process was effective and efficient and involved extensive and intensive field surveys by experienced staff. All features are identified and mapped, including any found during the earlier targeted species surveys.

Achieving Objectives and Demonstrated outcomes – Insufficient information

While the evaluators found that the BAHS do result in locating, recording and protection of habitat features there was insufficient available information to assess the effectiveness, or degree to which these surveys met the desired outcome – '*Environment features, habitat and risks are identified to ensure that protections and management actions are implemented to mitigate the impact of the forestry operation.'* Given the important role of the BAHS in meeting the CIFOA objectives for biodiversity and threatened species, monitoring and reporting of the implementation and effectiveness of this part of the approach should be a priority.

Value for Money – Efficient

This rating was based largely on the information received during the field visit. While the surveys themselves are time consuming the Standard Operating Procedure, SOP (FCNSW, 2021a) and the iPad recording and mapping system (MapApp) have helped to streamline the process and continual review and updating of these 'planning tools' has resulted in an efficient approach.

While habitat models are not currently required for prioritisation of broad area habitat searches, LiDar could be explored for habitat modelling to further increase efficiency.

Strategic Context – Appropriate

The BAHS are a key component of the overall approach to meet the ecological goal of the CIFOA - to maintain the pre-harvest forest diversity of forest-dependent species, habitats and structural legacies in the harvested and regenerating stand. As such they are entirely appropriate provided that there is adequate monitoring and feedback of results to ensure continual improvement.

3.3. Model Evaluation

Proud et al. (2023) provides an expert evaluation of the models used in the application of the CIFOA targeted survey conditions and protocols. The key findings from this evaluation were consistent with responses to the key questions in the online survey and comments received from interviewees (Munks et al., 2022b, Munks and Bell, 2023).

Overall, the models are rated **Minimally Appropriate** and **Minimally Effective**, with the possible exception of the Northern Corroboree Frog model. The models are outdated and are considered unreliable and need to be replaced with available updated and tested models (Proud et al., 2023)(see section 5. Conclusions and Recommendations). These include the NRC species occupancy models (Kavanagh et al., 2021) and the species-specific models for the Hastings River Mouse (Law et al., 2014) and Koala (Law et al., 2017).

Although known localities are also a trigger for a targeted survey these are also getting old. If the records are >20 years old, then they are removed from the dataset that triggers a requirement to

survey. Known localities that trigger surveys are also biased for some species. For example, there are five mountain top refuges for Rufous Scrub-bird in NSW. Three of these are monitored and these are the locations where most of the records come from. The underlying data for updating modelling and triggering surveys for Rufous Scrub-bird is therefore flawed because of this bias. For example, the Gibraltar Range doesn't get surveyed so does not get included in modelling, and the Border Ranges is cut off at the Queensland-NSW border so does not get surveyed on the Queensland side.

These locality data bias issues, as well as the need to update the CIFOA models should be addressed as a priority. Delays in the adoption of currently available new models appear to be related to the difficulty in demonstrating that the new models are more appropriate in terms of mitigating the impact of forestry operations on the species. A CIFOA process for the uptake of new models when they become available could be developed. This process would need to include validation of any new models in terms of both their ability to predict species occurrence and whether they are appropriate for the intended purpose.

3.4. Records and Record-keeping Evaluation

Bell and Munks (2023) evaluates the records and record-keeping associated with the application of the CIFOA targeted survey conditions and protocols. This evaluation took into account the responses to the relevant key questions in the online survey and comments received from interviewees (Munks et al., 2022b, Munks and Bell, 2023). An overall performance rating and brief rationale for the three main areas addressed in the evaluation are provided below. Recommendations for improvement are provided in Section 5.

Performance Ratings and Rationale

Table 7 Key evaluation questions for topic areas (KEQ) and performance ratings for records and record-keeping.

KEQ	Performance rating
Design To what extent are appropriate 'best practice' data recording methods used in the surveys? Is data recording and entry into an accessible database timely? How appropriate is data validation in terms of method and frequency? How reliable are rules around how records are filtered in databases (e.g., BioNet)?	Moderately Appropriate
Implementation To what extent are records interpreted appropriately in desk-top assessments? How effective are the known records and associated planning tools in ensuring the on-ground surveys are implemented as required?	Moderately Appropriate
Achieving objectives How effective have the known records been in informing adaptive management?	Minimally Effective

Design-Moderately appropriate

A key finding from the evaluation was that the FCMapApp is an excellent planning tool that has vastly improved the efficiency, consistency and accuracy of data collection and reporting associated with the

targeted surveys and broad area habitat surveys (BAHS). This digital device has greatly improved recording of the locations of species, habitat features and associated exclusion zones for uploading to the corporate biological database (i.e., BioData), avoiding data entry transcription errors, with automatic GPS tracking providing a simple measure of survey effort. Field guides to assist with species identification (flora and fauna) are being developed and progressively added to the FCMapApp.

Records required under the CIFOA conditions and protocols are validated through a rigorous procedure by FCNSW ecologists prior to entering on the BioNet. Some known records in BioNet expire after 20 years, but FCNSW has established a process to review these records and associated protective measures prior to removal. One key finding of this evaluation, however, is the limited requirement for upload to BioNet of additional information (associated with a species locality record) to assist in interpretation of the record. For example, records may not include the name of the observer and although detailed habitat data may have been recorded as part of FCNSW surveys it may not all be uploaded to BioNet. To some extent this is the result of limitations in BioNet data processes and protocols. Environmental conditions and habitat variables associated with species detections during BAHSs may not be recorded. Data that is collected or interpreted without acknowledging survey method-specific limitations and environmental conditions at the time of survey could lead to inaccurate interpretation of the results and consequences for management.

Although the FCNSW survey records are scrutinised carefully before uploading to BioNet there is little or no validation of data entered into the database from Inaturalist and other general public sources. This is a concern as it means that a record made by a highly skilled ecologist carries equal weight to a record made by a member of the public.

Implementation-Moderately appropriate

The procedures and planning tools associated with access and use of the known locality data in planning and implementation of surveys were considered excellent by the evaluators. There can be some delays in the data exchange between BioNet and FCNSW, but FCNSW are exploring alternative processes to ensure timely retrieval of data.

Factors that currently influence the reliability of known records in survey decisions include delays in the data exchange between BioNet and FCNSW, lack of additional information uploaded to BioNet to assist in interpretation of the record, lack of information about the reliability of the record, biases in the records resulting from survey history for some species. Reliance on known records as triggers for flora surveys without associated information on potential habitat can potentially lead to variable outcomes for threatened flora.

Achieving Objectives-Minimally effective

The rating for this area was based on the lack of a process to use data collected during the targeted surveys and BAHS to adapt management. A key finding from the evaluation was that there is a need for a process to use records and other information, collected as part of targeted species surveys and BAHSs, to inform the review and revision of the CIFOA conditions and protocols. While new records are being uploaded these are not being acted on or used to inform adaptation to the approach. The following example documented in (Bell and Munks, 2023) illustrates the requirement for such a condition (a continual improvement process with timelines):

> "*Conservation management of Drachophyllum macranthum requires the application of a Flora Road Management Plan (FRMP) under Condition 83 (and listed under Protocol 31) of the CIFOA. This species was delisted by the NSW Scientific Committee in February 2022. In February 2023 the requirements of the FRMP still remain in place. Drachophyllum micranthum is a species that readily resprouts following disturbance such as roadworks. The aim of the FRMP is to ensure the frequency of roadworks and associated maintenance is sympathetic to the species' conservation. This example demonstrates a level of inflexibility and/or protracted procedure associated with the*

relevant CIFOA conditions and protocols. The ongoing requirement for survey and management for this species is considered to add unnecessary cost and is inefficient use of FCNSW's ecological staff and resources."

3.5. Large forest owls

The CIFOA adopts a strategic landscape approach to the conservation of large forest owls. A targeted survey is not required for these species under the CIFOA. These species are managed through retention of 'large forest owl exclusion zones'. This landscape approach to owl conservation management was included in the remake of IFOAs (Slade and Law, 2017). Rules were generated in the 1990s based on owl survey results and the known distribution of suitable habitat. Exclusion zones were then developed, based on a general rule-set provided to managers. It is unclear to the evaluators whether or not modelled layers developed by species experts (eg., Kavanagh, 1997, Kavanagh, 2002) were used in the development of the 'exclusion zone rules'.

The CIFOA also includes a protocol covering areas where the proposed operation is on 'unassessed crown timber land' - *An area of other Crown-timber land that has not previously been subject to a relevant assessment and/or planning process to identify any areas of …. large forest owl exclusion zones …. that may occur within it* (see Appendix C1). The composition of any new 'large forest owl exclusion zones' for such unassessed areas are determined from modelled habitat. Where there is less than 20 percent of modelled habitat in the operational area then the exclusion zone can also contain high conservation value old growth forest and/or habitat most like that described in the relevant OEH species profiles and literature. A targeted survey is not required as part of this protocol.

The information gathered in this evaluation indicated the approach for these species needs review and improvement, primarily because of the out-of-date models and new locality data available on BioNet. Monitoring was highlighted as a priority.

4. Conclusion and Recommendations

The CIFOA monitoring program includes a number of broad strategies (Natural Resources Commission, 2020b). These strategies cover fauna, flora and habitat monitoring and an independent evaluation of forestry practice. Within this broad monitoring framework, the purpose of this evaluation project was to independently assess the effectiveness and suitability of the survey and modelling approaches currently required pre-harvest, in identifying the target species, habitats and other environmental features for protection and management. The outcome statement for Chapter 4, Division 1 of the CIFOA conditions was the focus of this evaluation - ***Environment features, habitat and risks are identified to ensure that protections and management actions are implemented to mitigate the impact of the forestry operation.*** Other parts of the CIFOA monitoring program evaluate the success of management actions.

Specifically, this evaluation addressed the following two high-level key evaluation questions:

1. 'Are the species and habitat survey and modelling conditions and practices effective in identifying the presence and location of native species and habitats in the area covered by the CIFOA?'
2. 'Do the species and habitat survey and modelling conditions and practices contribute to ensuring that protections and management actions are implemented to reduce the impact of the forestry operation?'

In answer to Question 1. Overall, we found that the CIFOA species and habitat surveys and associated models were reasonably effective in identifying the presence of the focal species and associated habitat features. The methods used were generally appropriate and were implemented through effective planning and field procedures. However, for some species the methods would benefit from

review and improvement. Recommendations for improvement included updating the models, addressing the decline in database records, updating survey and modelling methodologies using new scientific information, exploring alternative technology and ways to improve survey efficiency, provision for specialist advice in the planning process, and providing further training and guidance material for practitioners. Species that need priority attention included Marbled Frogmouth, Albert's Lyrebird, Rufous Scrub-bird and *Philoria* spp. The outdated models which remain triggers for surveys for many species are of particular concern and their replacement with newer available updated models (eg., Hastings River Mouse and Koala) is considered a priority.

In answer to Question 2. While there is room for improvement with many of the models and surveys, they do contribute to identifying the need for, and hence implementation of, protections and management actions at the site level. However, key general findings included the lack of follow-up monitoring and reporting of outcomes resulting in uncertainty around the effectiveness of some of the current practices and management actions in reducing the potential impact of forestry operations. Other recently initiated parts of the CIFOA monitoring program should help with this. The fauna monitoring program began with a pilot in 2021 and officially started in 2022 (Natural Resource Commission, 2023). The results will be used to assess the effectiveness of the protective measures delivered through the CIFOA, both landscape-scale and site measures, in maintaining focal species. Initiation of this major part of the monitoring program is considered an important step forward in the overall approach to fauna management through the CIFOA and should result in improved information on the status of multiple species.

Problems with the pre-harvest survey and manage approach of previous IFOAs have been well documented and were the main drivers of the IFOAs remake (State of New South Wales and Environment Protection Authority, 2014, Meek, 2004, Slade and Law, 2017). Slade and Law (2017) noted that '*the prescriptive surveys are very labour intensive and, while carried out by highly skilled specialist staff, do not provide data on long term trends or the effectiveness of protective measures because sites are not revisited post‑harvesting, due mostly to their design of complying with licence conditions rather than being appropriate for repeat surveys*.' This still largely applies to the current pre-harvest surveys. The conservation requirements of some of the species, particularly where the majority of known habitat for the species occurs outside of the state forest estate, might be better catered for through a Species Management Plan approach, with more emphasis on a precautionary approach to maintenance of habitat and follow-up trend and effectiveness monitoring.

Lack of follow up in monitoring and reporting outcomes was a key general finding in this evaluation. This should be identified as a priority area for improvement to effectively demonstrate the methods meet the stated objectives. Another was the need for a requirement (CIFOA condition) to adapt to new scientific information in a timely fashion (formal adaptive management process) and to allow flexibility in decision-making to facilitate continual improvement. This would include the development of a process for timely review of new information, including consideration of records collected by FCNSW as part of targeted species surveys and BAHSs, updating of models, species management plans and subsequent review and revision of the requirements under the CIFOA protocols.

Other general areas for improvement identified from the information gathered in this evaluation include:

- Undertake detection studies on species where needed to inform review and improvement of the survey protocols.
- Develop and conduct periodic scientific updates, seminars or field days for surveyors, those conducting 'in-house' training and auditors. This training should cover new information on the ecology of the species presented by species specialists and new survey techniques and management requirements.

- Prepare additional training and guidance documents for technical foresters and field technicians as FCNSW is currently reliant on the motivation of personnel in improving knowledge and skills.
- Add species profiles and call identification guides to the survey tools.
- Monitor and report annually on implementation and outcomes of the surveys for each species to help with assessment of the effectiveness of the survey conditions and protocols in meeting objectives and desired outcomes. This would also increase transparency around the conservation management of focal species through the CIFOA.
- Undertake post-harvest cross-tenure, multi-jurisdictional monitoring to inform the overall effectiveness of pre-harvest surveys in contributing to meeting conservation management objectives for species. Consider integrating the FCNSW monitoring program with related programs (eg., Wildfish, AWC) to increase data and spread resources. Monitor impacts of events like the wildfires as well as cumulative impacts. Undertake research projects to address key monitoring questions such as detectability.

The next sections cover more specific recommendations for the individual species and habitat surveys, models and record keeping.

4.1. Targeted Species Surveys

Table 8 provides a summary of the recommendations for improvements to the species and habitat surveys based on evaluation findings.

Table 8 Recommendations for improvement to pre-harvest surveys for species and habitat.

Species	Habitat descriptions and Models	Survey methods	Training	R&M	Alternative approach and other recommendations
Hastings River Mouse	Review and update the description, particularly the inclusion of 'or fern' in the protocols and focus on drainage lines. Replace the existing model with the more recent DPI model for this species and update using any new known localities and habitat information post-fires, including LiDar data.	Trial the use of new methods (eg., detection dogs, eDNA methods, camera traps) with the aim of increasing the efficiency of the surveys.	Initiate training by specialists to increase practitioner knowledge of species ecology, threats, survey methods, new technology and management requirements.	Initiate studies into the impacts of harvesting and implement monitoring, including resampling of undisturbed sites surveyed previously.	Consider taking a risk-based approach to management of habitat for this species through adoption of the draft SMP. This has an emphasis on monitoring rather than pre-harvest targeted surveys, expansion of monitoring sites and adoption of new models.
Koala	Northern region – Review and improve the 'browse prescription model' and koala browse tree definition using new information on occurrence of food trees in CIFOA regions (see recommendations in Natural Resources Commission, 2022a). Southern region – Consider adoption of a map that identifies areas of koala habitat suitability and triggers tree retention and restoration rules. Up to date Koala browse tree lists should be	Trial alternative survey methods such as acoustic recorders, detection dogs, thermal cameras, and drones. These could supplement the methods already used in pre-harvest surveys.	Initiate training for contractors covering new information on habitat and alternative survey techniques.		

Species	Habitat descriptions and Models	Survey methods	Training	R&M	Alternative approach and other recommendations
	a key input into the mapping. Supplement with targeted surveys in some areas but allow flexibility. Identify areas which require retention of trees used by koalas for purposes other than feeding, such as summer shelter trees, which could improve koala outcomes under the CIFOA. This might be particularly important where dramatic increases in temperature are predicted, with climate change (Natural Resources Commission, 2022a).				
***Philoria* spp.**	Review and update the habitat descriptions and models, considering individual species requirements.	Review and update the survey protocol for these species with a focus on the habitat descriptions and models, the timing of the surveys, the degree of survey effort (repeats) and individual species requirements (e.g., 'likely high-calling activity' needs defining for each species)	Conduct field days for surveyors to update knowledge of the species' ecology and alternative survey methods.	Test alternative survey methods with the aim of increasing the efficiency and effectiveness of the surveys.	
Pouched frog	Review and update the habitat model taking into account new	Include a requirement in the protocol to take known locality data into account	Conduct training for surveyors to update knowledge of the	Test alternative survey methods for detectability, accuracy,	

Species	Habitat descriptions and Models	Survey methods	Training	R&M	Alternative approach and other recommendations
	records. Encourage collaboration between modellers. Review and clarify the protocol wording – meaning of 'adjacent', the habitat description, wording of parts (iv) and (v) (see 3.3.1 in Munks and Bell (2023) for more information).	when deciding on the need for a habitat assessment and include a requirement to record environmental conditions at the time of survey, to help with interpretation of the results. Provide the optimal conditions for surveys in the protocols or guidance documents to improve efficiency (eg., narrowing the survey season to September-January to make surveys more efficient and effective).	species' ecology and alternative survey methods. Build links with species specialists through field days.	efficiency (eg., detection dogs, eDNA and remote acoustic recording devices).	
Northern Corroboree Frog		Clarify the 'extent' of the survey area in the protocol. Review the timing and frequency of the surveys to increase detectability and efficiency of the surveys. Allow flexibility in timing of the surveys to allow for 'seasonal factors and climate-change related factors' and based on expert advice.		Quantify the impact of forestry activities on this species and its habitat to inform a reassessment of the need for management.	Consider development of a Species Management Plan for this species as an alternative to the current 'survey and manage' approach.

Species	Habitat descriptions and Models	Survey methods	Training	R&M	Alternative approach and other recommendations
Albert's Lyrebird	Update the models to incorporate more recent location records and information on the species.	Review the survey methodology with attention to probability of detection, considering duration, repeats and timing. Consider the potential of passive acoustic monitoring to assist in species detectability and survey coverage. Ensure that relevant habitat and environmental data are collected during pre-operational surveys to provide for adaptation of survey methodology and habitat models.	Improve planning tools, and training in ecology, call and habitat identification and survey methodology.		Explore opportunities for collaboration with other agencies and specialists in pre-harvest surveys and assessment of the effectiveness of management actions to protect the species.
Rufous Scrub-bird	Update the habitat models and consider modelling the two subspecies separately if/when data are available. Review the habitat definition including in a post-fire landscape.	Provide for specialist advice/input to decision making on where, when, and how to survey, and to assist in identification of the species. Consider detectability in interpretation of the survey results and the likely proximity of territories. Consider the use of passive acoustic monitoring to	Train field ecologists in call and habitat identification, and survey methodology.	Measure the effectiveness of the desk-top assessments and surveys using pre-harvest survey results.	Explore opportunities for collaboration with agencies/organisations/specialists in pre-harvest surveys and assessment of the effectiveness of management actions to protect the species.

Species	Habitat descriptions and Models	Survey methods	Training	R&M	Alternative approach and other recommendations
		increase the number of sites and geographical coverage of surveys, and species detectability.			
Marbled Frogmouth	Update the model to incorporate more recent location records and information on the species.	Ensure that relevant habitat and environmental data are collected during pre-operational surveys to provide for adaptation of survey methodology and habitat models. Provide for specialist advice/input to decision making on where, when, and how to survey, and to assist in identification of the species. Consider the use of passive acoustic monitoring to increase the number of sites and geographical coverage of surveys, and species detectability. Review consistency of survey effort, including factors such a time of night,		Re-assess detectability when following the CIFOA survey protocol and across seasons to ensure meaningful survey results.	Consider development of a Species Management Plan for this species as an alternative to the current approach. Explore opportunities for collaboration with agencies/organisations/specialists in pre-harvest surveys and assessment of the effectiveness of management actions to protect the species.

Species	Habitat descriptions and Models	Survey methods	Training	R&M	Alternative approach and other recommendations
		number of repeat surveys, season of the survey.			
Flora spp	Develop flora species habitat models to better focus pre-operational surveys.		Ensure field ecologists are suitably skilled and experienced in botanical survey and plant species and habitat identification. This may involve ongoing training and development of species-specific survey guidelines.	Re-survey record locations and undertake systematic surveys for expiring flora species' records.	Review prioritisation of flora species for targeted survey and sensitivity to forestry activities. Apply an adaptive approach to the survey and management of flora species which takes account of threat risk.

4.2. Large forest owls

- **Models.** Update the owl models used through the CIFOA.
- **Monitoring and review.**
    - Conduct an expert review of the 'Large Forest Owl Exclusion Zones' taking into account new records and updated owl models.
    - Conduct cross-tenure, multi-jurisdictional monitoring of large forest owls to inform continual improvement of CIFOA conditions and protocols for these species.
- **Nest site surveys.** Consider nocturnal pre-harvest surveys for nest sites as part of BAHS.

4.3. Broad Habitat Assessment

- **Habitat models.** Explore the use of LiDar for habitat modelling (eg., hollow-bearing trees) to further increase efficiency of the BAHS.
- **Survey methodology and guidance.**
    - Develop guidance around search effort and methods for the identification of some key habitat features (eg., owl/glider nests, dens or sap feed trees) including consideration of nocturnal surveys in some areas, to detect and protect these features.
    - Add a protocol allowing flexibility in identification of key habitat features at-risk from forestry activities and the option to seek expert advice.
    - Develop guidance material to assist with identification of habitat features and ensure consistency with other available information.
- **Training.** Conduct annual training and/or field days with species and habitat specialists. Such training should include all involved in the planning, implementation and compliance monitoring of the BAHS (eg., forestry technicians, ecologists, auditors, planners and managers) to ensure consistent understanding and identification of habitat features, the risk from forestry operations and appropriate management.
- **Monitoring and reporting.** Ensure monitoring and reporting of the implementation and effectiveness of the BAHS to increase confidence in the approach and inform continual improvement.

4.4. Models

- **Adopt recent models.**
    - Adopt NRC species occupancy models and species-specific models (HRM and Koala) and discontinue use of RFA models.
    - Use Koala Habitat Information Base data and regional-level coarse-scale habitat models to support finer-scale species-specific models (e.g., Koala model developed by Law et al., 2017).
- **Improve methodology.**
    - Use independent survey data to validate new models (see Law et al., 2017).
    - Remove or model spatial/temporal autocorrelation (see Law et al., 2014).
    - Limit use of correlated covariates (Law et al., 2014) to improve inference of the significance of model covariates.
    - Undertake power analysis, survey gap analysis and species detectability to inform survey design.
    - Develop and add model covariates that describe the landscape at a scale relevant to species with large home ranges, or that more accurately reflect key habitat characteristics.

  - Develop new environmental covariate layers that address significant disturbances (e.g. fire and logging), additional threats (e.g. invasive species) and anticipated climate extremes (see Kavanagh et al., 2021).
  - Develop new methods for highly mobile species (RFA/NRC/EES modelling is not appropriate for highly mobile species).
- **Review and update.**
  - Include a requirement under the CIFOA for periodic review and updating of models and concomitantly, improving the effectiveness of the modelling conditions and practices.
  - A CIFOA process for the uptake of new models when they become available could be developed. This process would include validation of any new models in terms of their ability to predict species occurrence and demonstration of their appropriateness for the intended purpose.

4.5. Records and Record-keeping

- **Field recording.**
  - Provide ongoing support and funding for FCMapApp – an excellent FCNSW field based ecological planning and recording tools.
  - Include additional comments associated with records to assist with the interpretation of the record (e.g., associated habitat data).
- **Data management and storage.**
  - Review data checking processes regularly and ensure tools are operating and interrogating the correct data.
  - Provide support and funding for centralised data management, analysis, reporting, feedback loops and appropriate long-term data storage facilities.
  - Improve articulation of the method and frequency of data validation in the CIFOA conditions and protocols.
  - Capture historical data collected by FCNSW digitally - a huge amount remains on survey sheets in paper form. Years of data on more common species is not able to be interrogated and used to assess the impact of forestry practices over time. These larger data sets are important to help understand the impacts on ecosystems and functional changes that may have taken place. Resources are required for this data to be captured and uploaded.
- **Monitoring and review.**
  - Conduct regular, consistent survey/monitoring as a basis for adaptive management and to counter the diminishing record dataset resulting from the 20-year invalidation period.
  - Use historic records and records from ongoing surveys, projects and the biodiversity monitoring program to assist FCNSW to embrace adaptive management. The CIFOA could better articulate pathways for adaptive management according to an evidence-based approach and facilitate timely approvals for improvements to conditions and protocols.
  - Review the quality of database records and undertake additional systematic species surveys. Diminishing records are reducing the value of records as triggers for 'survey and management'.

4.6. Final comment

This evaluation has resulted in many recommendations for improvements to the pre-harvest targeted surveys and associated models. However, addressing these should not take emphasis and resources away from the monitoring component of the CIFOA. The need for monitoring was raised by many of those who contributed to this evaluation. All three types of monitoring are required (implementation, effectiveness and trend) as well as more targeted research to answer questions relevant to informing improvement of the CIFOA survey conditions and protocols. The trend monitoring is particularly important to assess whether the CIFOA is working for the large home range species (eg., large forest owls, gliders and koalas).

An assessment of the degree to which the survey requirements and outcomes were communicated to the broader community was considered beyond the scope of this evaluation and was not considered in the final ratings. However, the issue of lack of transparency and accessibility of information about what is done was raised by many of the interviewees. The evaluators were also surprised by the relatively low level of awareness amongst some of the species experts and ecologists who were interviewed as part of this evaluation. Raising awareness of the effort taken through the CIFOA for the protection of species at risk from forestry activities could increase confidence in the approach.

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6. Appendices

Appendix A. Scope of the evaluation and evaluator experience (from project quote)

Evaluation Framework

A mixed method evaluation approach (for concept see, Palinkas et al., 2019) will be taken, drawing on both qualitative and quantitative methods. The steps will broadly involve:

1. Framing the evaluation – Compiling contextual information about purpose of the evaluation, the objectives of the surveys and modelling and associated management practices, expected outcomes etc. This will include a literature review component.
2. Identifying and engaging with relevant FCNSW, EPA, DPI Forest Science and other personnel and stakeholders. This will include development of the workshop and interview components of the evaluation.
3. Refining the key evaluation questions and determining the appropriate evaluation method (qualitative or quantitative) and outcome criteria.
4. Assessing performance against the key evaluation questions (focussing on effectiveness, appropriateness, and efficiency).
5. Synthesising and reporting on the evaluation findings and making recommendations.

Evaluating survey methods, habitat survey approaches and broad habitat searches

Both qualitative and quantitative methods will be used in the evaluation of the adequacy of species and habitat surveys. These will include examining:

1. Uncertainty in the data/information used in the selection of a particular species or habitat survey approach. Including assessment of differences in the literature, between the literature and experts and between experts (Turner et al., 2019).
2. Survey coverage (eg., survey data should reflect the spatial distribution of the target species populations, including areas where there is a risk of impact from forestry operations).
3. Survey frequency, with regard to the objective. For example, if the objective is to monitor population trends in a particular area or habitat then ideally a survey should be undertaken at the same time of year. However, the frequency between years may vary depending on the costs and required effect size.
4. Survey design used for each species – timing, desk-top assessment (eg., using existing databases and remote sensed data) vs site visits, costs etc. This will include a literature review of detectability studies for each survey method. When data are appropriate (and if the project budget/timing allows) occupancy analysis and power analysis will be explored.
5. Surveyor competency and training. The content, delivery and frequency of training courses and field days will be reviewed.
6. The degree to which surveys are implemented as required through the required planning procedures. This would include an assessment of the efficacy of the actual survey design implemented.

Evaluating modelling

Model evaluation will include assessing:

1. Inclusion of the data used in the analysis and appropriateness of any data cleaning that took place prior to the analysis (spatial and temporal accuracy).

2. The statistical methods used in model development, including who was involved, assumptions of the statistical approach, review of any code used to ensure the analyses are transparent, explicit and repeatable, whether the methods are transparent and repeatable, what model averaging method was used (eg., AIC, error fitting etc.).
3. Consideration of spatial and temporal uncertainty in parameter estimates, model structure and predictions. An example of temporal uncertainty may include changes in climate and fire frequency/intensity.
4. Internal model validation with each method used (eg., independent dataset from new sites, cross-validation using % of model dataset, etc.)

Evaluation of records and record-keeping practices

An important component of any monitoring program is the recording and communication of results. Evaluation of record keeping practices will include assessing:

1. The method of data recording.
2. The time between collection of the data and entering into an accessible database.
3. Any data validation procedures. For example was image recognition software used? Was there any specialist verification of photographs for correct species ID? Were flora records verified by more than one botanists with demonstrated field botany skills?
4. The procedures and planning tools used to deliver the information to practitioners and policy makers to inform decision-making.
5. 'Pathway to delivery' procedures, including any endorsement processes involved in data or planning tool release.

The scope of services will primarily be undertaken working remotely with communications via email, phone and a screen sharing platform such as Zoom, Teams or Skype.

All raw and processed data will be provided to the Commission project team in line with the forest monitoring data management framework and public accessibility requirements.

About the Independent Evaluators

Dr Sarah Munks

Sarah has over 27 years' experience in research and natural resource management. A focus of her work has been integrating scientific research into policy and management practices in the agricultural and forestry sector. She has contributed to many reviews, research, and monitoring projects of relevance to the management of biodiversity in the forestry context. Her research interests include threatened forest fauna species, management of freshwater habitats, effectiveness monitoring and capacity building. She has co-supervised 20 higher degree students (5 honours, 5 Masters and 11 PhDs) and has been a partner or supporting investigator on two major ARC funded projects. She has contributed to 66+ peer-reviewed scientific papers and 47 reports, manuals and decision support systems for a wide audience including community groups, forest planners and policy makers.

In her positions with the Tasmanian Forest Practices Authority, particularly as Manager of the Biodiversity Section in the Research and Advisory Division, Sarah developed an expert knowledge of forest management practices in Tasmania and elsewhere. In that role Sarah developed management and monitoring strategies for biodiversity, including forest-dependent threatened species covered by State and Federal legislation; undertook reviews of national and international approaches to biodiversity conservation and effectiveness monitoring in production forests (funded by Maxwell Jacobs Award and Commonwealth funding); contributed to the development of processes and procedures to ensure that the intent of the Tasmanian *Threatened Species Protection Act* is met in areas covered by the Tasmanian Forest Practices System; developed landscape-scale approaches to contribute to the conservation of biodiversity in areas outside of reserves and made a significant contribution to the review of the PNG logging code of practice, funded by the Australian Government

and FAO (project GCP/PNG/003/AUL "Promoting sustainable forest management by developing effective systems of forest planning, monitoring and control in Papua New Guinea).

Sarah currently consults to a variety of local and national organisations on biodiversity and environmental, particularly forestry, management issues. Sarah is an Adjunct Senior Researcher at the University of Tasmania.

Dr Phil Bell

Phil is a consultant ecologist and researcher with extensive in-depth knowledge and professional experience in biodiversity conservation and forest management in Tasmania, New South Wales and the Northern Territory. Phil has a PhD in conservation biology and 30 years experience in research, survey and management of biodiversity assets. He is a Research Associate, School of Natural Sciences and an Affiliated Researcher, ARC Centre for Forest Value at the University of Tasmania. In 2019 Phil received two awards recognising his collegiate and collaborative work ethic including the Tasmanian 'Forest Practices Award' for excellence in 'Advice and Services to Forest Managers' and (jointly with Forico Pty Ltd) the Ecological Society of Australia, Practitioner Research Partnership Award.

Phil has specific experience in research, management and monitoring of threatened species (invertebrate and vertebrate fauna, and vascular flora) and threatened ecological communities (forest and non-forest communities) in Tasmania, New South Wales and the Northern Territory. His experience in NSW was gained through his role as Senior Threatened Species Officer, Office of Environment and Heritage, NSW (2014-2016) and more recent consultancies. He has been the main driver in development of policies and guidelines for threatened species and biodiversity management; interpretation and application of environmental planning and impact assessment legislation; species recovery planning; applications for grants, research and monitoring coordination and collaboration; strategy development and planning; and, biodiversity conservation planning, facilitation and negotiation.

Dr Perpetua Turner (Contributed to online survey, interim reports and model evaluation)

Perpetua is an ecologist with over 20 years' experience in forest, fire and biodiversity conservation ecology with strong science-to-practice credibility. She has proven skills in collecting and collating data from various sources and expertise in developing these data through GIS and modelling. Using ArcGIS and ENVI she developed a spatial decision support tool for use in emergency management planning during the 2016 Lake McKenzie wildfire in Tasmania, successfully protecting areas with assets at risk (Pencil Pine, *Athrotaxis cupressioides*). Together with colleagues she used generalised linear modelling/MAXENT to predict nest use/nest presence for the endangered Wedge-tailed eagle, and generalised linear modelling to predict the likelihood of tree survival after disturbance. Her statistical analysis skills include using R and GIS to run multivariate, univariate and spatial statistics to analyse vegetation, species and environmental data. She has a sound understanding of project design, data collection methods, and appropriate methods for statistical analyses.

Dr Roland Proud (Model evaluation -(Proud et al., 2023))

Roland is a consultant statistician and ecologist with over ten years work experience in academic institutes and private industry. He has a master's in physics and astrophysics (University of Sheffield, graduation 2008), a master's in marine management (University of St Andrews, graduation in 2012) and a PhD in marine ecology (University of St Andrews and University of Tasmania, graduation in 2016). Roland is a certified expert in the programming language SAS and has worked for government institutions and banks across the UK as a SAS consultant. He has also worked as a collaborator with The Analytical Edge Pty. Ltd. over the past 5 years on more than 20 projects, delivering statistical analysis and modelling results to Australian state and federal government agencies, NGOs, private industry, and academic researchers. Roland has run his own data analytics company, Cupar Analytics Ltd (based in Scotland, UK), since 2021, which specialises in building end-to-end (i.e., data storage, data processing, data modelling and reporting in web-based applications) data services for

environmental sciences and management (e.g., fisheries). He also works part-time as a research fellow at the University of St Andrews, where he supervisors PhD students and contributes to on-going research as a member of the pelagic ecology research group.

Dr Joanne Potts (Contributed to the Evaluation Strategy (Munks et al., 2022a))

Joanne is an Accredited Statistician with the Statistical Society of Australia. She completed both her Bachelor of Science (University of Melbourne, graduation 2003) and PhD studies in statistics (University of St Andrews, Scotland, graduation 2011). She has over ten years work experience as a statistician within government agencies (Arthur Rylah Institute for Environmental Research, Victorian State Government), academic institutes (University of Southampton, England and the University of

Melbourne) and private industry. Since 2012, Joanne has run her own statistical consulting firm, The Analytical Edge Pty. Ltd., based in southern Tasmania. During this time, she has successfully delivered numerous nationally and internationally funded projects to several state and federal government agencies, NGOs, private industry and academic researchers, advising on survey design and analysing data with a diverse area of application.

Appendix B. Evaluation criteria and performance standard rubrics (from, Munks et al., 2022a).

Evaluation criterion	Description	Example questions
Effectiveness	Relationship between objectives, outputs and outcomes. Assessed by considering how effectively the objectives were achieved, the findings were communicated and whether it achieved or supported desired outcomes.	To what extent does the survey achieve its objective? To what extent is the survey producing meaningful results?
Appropriateness ('Fit for purpose')	This considers how well 'science or industry best practice' has been taken into account and other similar initiatives and was appropriate considering the project objective or purpose. Also assessed through comparing the survey with the strategic/policy requirements (eg., CIFOA protocols and conditions and other policy and legislation requirements).	To what extent does the survey align with the broad goal of the CIFOA?
Efficiency	A measure of how resources, expertise, time etc. are converted into outputs (eg., survey effort, data, reports, change in management). Can include assessment of whether systems are in place for activities to be implemented.	Is the survey method timely and cost-effective?

Criterion	Minimally effective	Moderately effective	Effective
Effectiveness – achieved objectives	Majority of objectives only partially or not achieved.	Moderate number of objectives achieved. Some partially, but likely to be achieved over longer timeframe.	Majority of objectives achieved.
Effectiveness-implementation	Systems, processes and planning tools for implementation ineffective	Systems, processes, planning tools for implementation moderately effective	Systems, processes, planning tools for implementation effective
Effectiveness – demonstrated outcomes	The surveys and models have only been minimally communicated to management and have only resulted in minimal or no change to management	Some survey outcomes and models have been communicated to management, but have only resulted in a moderate change to management	All results have been communicated to management and have been used to inform adaptive management
Effectiveness-Training	Training and field days have not been delivered; or are mostly ineffective in terms of improving	Training and field days have been delivered but are mostly ineffective in terms of improving	Training and field days have been delivered and are effective in terms of improving

	knowledge/competency of surveyors	knowledge/competency of surveyors	knowledge/competency of surveyors
Criterion	**Minimally appropriate**	**Moderately appropriate**	**Appropriate**
Appropriateness-Design	Poor alignment with current 'best practice' methods in the scientific literature and as recommended by experts	Moderate alignment with current 'best practice' methods in the scientific literature and as recommended by experts. However, the design was not appropriate for the objectives	Good alignment with current 'best practice' methods in the scientific literature and as recommended by experts. Design appropriate for the objectives
	No evidence of adaptation of methods or use of outputs after major environmental change (eg., after wildfire)	Some evidence of adaptation of methods or use of outputs after major environmental change (eg., after wildfire) but slow uptake	Evidence of adaptation of methods or use of outputs after major environmental change (eg., after wildfire) in a timely fashion
Appropriateness-Training	Training content and delivery is not appropriate for the audience resulting in poor understanding of the requirements and poor interpretation of results	Training content is good but not delivered appropriately for the audience resulting in moderate understanding of the requirements and poor interpretation of results	Training content is excellent and delivered appropriately for the audience resulting in high understanding of the requirements and excellent interpretation of results
Appropriateness – Strategic context	Low level of alignment with CIFOA conditions and protocols and broader FIMP requirements	Moderate level of alignment with CIFOA conditions and protocols and broader FIMP requirements	High level of alignment with CIFOA conditions and protocols and broader FIMP requirements
Criterion	**Minimally efficient**	**Moderately efficient**	**Efficient**
Efficiency – Value for money/time	Fails to produce the intended quality and quantity of data (or other output) within the available resources and in a timely fashion. No evidence of exploration of more efficient methods.	In most cases, but not all, succeeds in producing the intended quality and quantity of data (or other output) within the available resources and in a timely fashion. Some evidence of exploration of more efficient methods.	Succeeds in producing the intended quality and quantity of data (or other output) within the available resources and in a timely fashion. Evidence of exploration of more efficient methods.
	No evidence of collaboration and communication with other organisations undertaking similar work.	Some evidence of collaboration and communication with other organisations undertaking similar work, but no pooling of data or resources.	Evidence of collaboration and communication with other organisations undertaking similar work, some pooling of data or resources.

Appendix C1. Summary of CIFOA Conditions and Protocols relevant to the Current Evaluation of Targeted (pre-operational) Species and Habitat Surveys, Models and Record-keeping

Condition/Protocol	Topic	Requirements
CONDITIONS		
Div 1, Chapter 4	**Outcome Statement**	Environment features, ***habitat*** and risks are identified to ensure that protections and management actions are implemented to mitigate the impact of the ***forestry operation***.
56.	**Targeted flora surveys and targeted fauna surveys**	56.1 A ***forestry operation*** (other than ***road maintenance***) must not be conducted in any part of an ***operational area***, unless a ***targeted flora survey*** and/or ***targeted fauna survey*** has been undertaken in that part of the ***operational area*** no greater than seven years prior to that ***forestry operation*** commencing in that area. 56.2 Each survey must: (a) be carried out by a ***suitably qualified person***; (b) be carried out in, and within 100 metres of, the ***base net area*** of the ***operational area***; (c) search for each of the ***species*** set out in conditions 20.3 and 20.4 of **Protocol 20: Preoperational surveys**, unless otherwise specified in that condition; and (d) be conducted and reported in accordance with condition 20.3, 20.4 and 20.5 of **Protocol 20: Pre-operational surveys**. 56.3 Any ***subject species*** or ***habitat feature*** detected in a ***targeted flora survey*** and/or ***targeted fauna survey*** must be: (a) managed and protected in accordance with the applicable requirements of the ***approval*** and ***protocols***; and (b) mapped in accordance with condition 117 of the ***approval***. 56.4 Despite condition 56.1, and subject to condition 57.1, a ***targeted flora survey*** and/or ***targeted fauna survey*** is not required for a ***species*** to which conditions 66, 67, 68, 69, or 71 of the ***approval*** apply if ***FCNSW***: (a) has recorded in the ***operational plan*** that it will comply with conditions 66.2, 67.2, 68.2, 69.2, 69.3 or 71.1(c) of the ***approval***, in relation to the ***species***, as relevant; and (b) complies with those conditions, as applicable.
57	**Broad area habitat searches (BAHS)**	57.1 A ***forestry operation*** (other than ***road maintenance***) must not be conducted in any part of an ***operational area*** unless: (a) at least 100 metres in advance of the ***forestry operation*** occurring in any part of the ***operational area,*** the ***base net area*** has been broken up into ***patches*** that are no more than 10 hectares in size and mapped in accordance with condition 117 of the ***approval***; (b) a ***broad area habitat search*** has been undertaken in accordance with condition 57 of the ***approval*** in the ***patch*** that contains that part of the ***operational area***; and (c) the ***broad area habitat survey*** was completed within a maximum of six months prior to the commencement of the ***forestry operation*** in that ***patch***. 57.2 Each search must: (a) be carried out by a ***suitably qualified person***;

Condition/Protocol	Topic	Requirements
		(b) be carried out in, and within 100 metres of, the ***base net area*** of the ***operational area***; (c) look for, identify, and record the ***habitat features*** and ***species*** listed in Table 2 (Appendix A) of this condition; and (d) be conducted in accordance with condition 20.2 and 20.5 of **Protocol 20: Pre-operational surveys**. 57.3 All ***habitat features*** or ***species*** listed in Table 2 (Appendix A) and identified under condition 57.2(c), or which were not identified under that condition but identified later during the carrying out of ***forestry operations***, must be: (a) protected in accordance with the requirements for that ***habitat feature*** or ***species*** in the ***approval*** and the ***protocols***; and (b) mapped in accordance with condition 117 of the ***approval.***
57	**Broad area habitat searches (BAHS) after post-harvest burns or forest product operation**	57.4 Condition 56.1 and 57.1 do not apply to a ***post-harvest burn*** or ***forest product operation*** if: (a) the ***post-harvest burn*** or ***forest product operation*** is conducted in a part of an ***operational area*** in which a ***targeted flora survey*** and/or ***targeted fauna survey*** and ***broad area habitat search*** was conducted for an associated ***harvesting operation***, as set out in the ***operational plan***; and (b) a ***targeted flora survey*** and/or ***targeted fauna survey*** and ***broad area habitat search*** conducted for the associated ***harvesting operation*** and the ***post-harvest burn*** or ***forest product operation*** were conducted in accordance with the ***approval***.
57	***Flora species* that requires a *flora road management plan***	57.5 Where a ***species*** that requires a ***flora road management plan*** (as listed in Part 3, Table 4 of condition 31.2 of **Protocol 31: Matters covered by the approval**) (Appendix B) has been recorded within, or within five kilometres of the boundary of, the ***operational area*** a ***road maintenance*** operation must not be conducted in any areas of ***potential habitat*** for that ***species*** unless: (a) a ***flora road management plan*** applicable to the ***species*** has been prepared by ***FCNSW*** and approved by the ***EPA***; (b) unless other provisions regarding survey of the ***species*** are expressly identified in the approved ***flora road management plan***, a ***suitably qualified person*** must search: i. areas of ***potential habitat*** in, and within 10 metres of, the planned ***road maintenance*** operation; ii. in the relevant survey season (if any) identified in Part 3, Table 4 of condition 31.2 of **Protocol 31: Matters covered by the approval**; iii. at least 100 metres in advance of ***road maintenance*** in that part of the ***operational area***; and iv. no more than six months (or other period if identified in the ***flora road management plan***) prior to ***road maintenance*** in that part of the ***operational area***; (c) the search effort and results are recorded in accordance with condition 20.5 of **Protocol 20: Pre-operational surveys**; and (d) any requirements regarding protection of the ***species*** or disturbance to sites identified in the approved ***flora road management plan*** are applied in a manner that reflect the results of condition 57.5(b) above.
58	**Incidental records of**	58.1 Where ***FCNSW*** identifies a ***subject species***, ***habitat feature*** or ***threatened species*** that requires protection under the ***approval***, before or during the planning, surveying or carrying out of a ***forestry operation***, ***FCNSW*** must:

Condition/Protocol	Topic	Requirements
	species and habitat features requiring protection	(a) immediately apply the conditions of the ***approval*** to that ***subject species, habitat feature*** or ***threatened species***; (b) record the details of the ***subject species, habitat feature*** or ***threatened species***; (c) map the ***subject species, habitat feature*** or ***threatened species*** in accordance with condition 117 of the ***approval***; and (d) update the ***operational plan*** to include the requirements at condition 58.1(b).
65	**Koala browse tree retention (*Upper North East Subregion* and *Lower North East Subregion*)**	65.1 The following trees must be retained for the duration, and at the ***completion*** of, each ***forestry operation*** in accordance with **Protocol 23: Tree retention**: (a) a minimum of 10 ***Koala browse trees*** per hectare of ***net harvest area*** where ***Koala browse prescription 1*** applies; (b) a minimum of five ***Koala browse trees*** per hectare of ***net harvest area*** where ***Koala browse prescription 2*** applies and in any (or remaining part of a) ***compartment*** where a ***contemporary koala record*** exists but is not otherwise attributed ***Koala browse prescription 1*** or ***2***; and (c) all ***Koala browse trees*** in areas where the minimum coverage of ***Koala browse trees*** set out in conditions 65.1(a) and 65.1(b) does not exist in the ***net harvest area*** before the commencement of the ***forestry operation***. *Note: For the purposes of determining the rate of tree retention in the **net harvest area** under condition 65.1(a) and 65.1(b), **Protocol 23: Tree retention** must be used*
75	**Koala – Species Specific Conditions**	75.1 A ***suitably qualified person*** must visually assess each tree for Koalas immediately prior to it being felled, where: (a) ***Koala browse prescription 1*** or ***Koala browse prescription 2*** applies; or (b) there is a ***contemporary Koala record*** in any ***operational areas*** in the ***Southern Subregion*** or ***Eden Subregion***. 75.2 If a Koala is located in a tree, an ***exclusion zone*** with a radius of 25 metres or greater must be retained around the tree. The ***exclusion zone*** may be removed once the Koala moves from that tree. 75.3 ***Koala browse prescription 2*** must be applied to the remainder of an ***operational area*** where ***evidence of Koala*** is detected during a ***harvesting operation*** in an area which is not identified in condition 75.1. 75.4 ***FCNSW*** must maintain records, updated each week, in accordance with **Protocol 3: Operational tracking**, to demonstrate condition 75 of the ***approval*** has been applied. (see also Protocol 6.7)
117	**Field mapping**	117.2 The boundary, point location or linear extent of the following must mapped, or re-mapped in advance of and during a ***forestry operation*** in any part of an ***operational area***: (c) any features required to be mapped under: (ii) **Protocol 20: Pre-operational surveys** *(i.e. **broad area habitat search** and **targeted flora and fauna survey** track logs)* 117.4 Any ***ESA*** or other feature mapped or re-mapped under condition 117.1 or 117.2 must be (a) mapped in accordance with **Protocol 36: Field mapping**; and

Condition/Protocol	Topic	Requirements
		(b) quality assured and incorporated into a ***spatial dataset*** in accordance with **Protocol 34: Spatial datasets**; and (c) made available to officers of ***EPA,*** and ***DPI*** in accordance with **Protocol 35: Data and information management**.
118	**Species data transfer to NSW BioNet**	118.1 A ***record*** of a ***plant*** or ***animal*** that is required to be identified or protected by the ***approval*** must be provided by ***FCNSW*** to ***NSW BioNet*** in accordance with **Protocol 35: Data and information management** as soon as practicable, but no more than three months after the detection of each ***record***.
PROTOCOLS – Administrative Conditions		
GENERAL		
Protocol 6	**Suitably qualified persons-training and experience**	6.4 Broad area habitat search – staff skill and training A person conducting a ***broad area habitat search*** must: (a) be properly trained and proficient, to the ***EPA's*** satisfaction, in the identification of flora and fauna ***subject species*** and ***habitat*** within their area of operation. This includes ***subject species*** and features listed in Table 2 in condition 57.3 of the ***approval***; and (b) undergo annual refresher training via semi-formal or formal delivery methods on the identification of ***subject species*** and ***habitat***; and (c) be up to date on new listings of ***threatened species***, ***populations*** and ***EECs*** under relevant legislation. 6.5 Targeted survey – surveyor experience A person undertaking a ***targeted flora survey*** or a ***targeted fauna survey*** under **Protocol 20: Pre-operational surveys** must: (a) be ecologically trained and capable of identifying flora and fauna ***subject species*** and habitat features relevant to their area to the ***EPA's*** satisfaction; and (b) undergo annual refresher training via semi-formal or formal delivery methods on the identification of ***subject species*** and ***habitat***. 6.6 TEC (indicative) For the purpose of identification of ***TEC (indicative)***, a ***suitably qualified person*** is a person who has extensive and bioregionally-specific experience in the field identification of ***TECs***, as well as similar ecological communities that may be confused with ***TECs***. 6.7 Assessment of Koala presence during harvesting A person tasked with undertaking assessments of the presence of Koala in trees in the course of ***harvesting operations*** (for the purpose of condition 75 of the ***approval***) must: (a) be properly trained and proficient, to the ***EPA's*** satisfaction, in: (i) the identification of Koalas; (ii) preferred ***Koala browse tree*** identification; and (iii) Koala ***habitat*** use and habits; and

Condition/Protocol	Topic	Requirements
		(b) undergo periodic refresher training on any new or updated information on the subject matter listed in condition 6.7(1)(a) of this ***protocol*** via semi-formal or formal delivery methods on the matters in (a) above and when new information on Koala ***habitat*** use or survey methods become available.
Protocol 20.1(a)	**Area covered**	***broad area habitat search***, ***targeted flora survey*** or ***targeted fauna survey*** rate of effort per hectare(s) excludes any areas which at the time of the survey or search are already mapped in the 'Tree_Retention_Clump' ***spatial dataset*** or 'Wildlife_Clump' ***spatial dataset*** as a ***tree retention clump*** or ***wildlife habitat clump***; ***base net area*** is a reference to the ***base net area*** of the ***operational area*** for the applicable ***forestry operation***
Protocol 20.1(b)	**Inclusion in plans**	information obtained pursuant to this ***protocol*** to be included in the ***operational plan*** for proposed ***forestry operations***
BROAD AREA HABITAT SURVEYS		
20.2(b)	**Broad area habitat search**	(1)A ***broad area habitat search*** must: (a) cover the ***base net area*** of each ***patch***; (b) cover areas 100m outside the ***base net area*** where habitat suitable for a ***subject species***, or a ***habitat feature*** listed in Table 2 of the ***approval***, is known or likely to exist; (c) cover tracks or roads where habitat suitable for a ***subject species***, or a ***habitat feature*** listed in Table 2 of the ***approval***, is known or likely to occur adjacent to tracks and roads; and (d) record all ***habitat features*** and ***subject species*** listed in Table 2 of the ***approval***. (2)Where a ***patch*** subject to a ***broad area habitat search*** contains areas of ***impenetrable understorey*** which means that the requirements of condition 20.2(1) of this ***protocol*** cannot be met: (a) all areas of the ***patch*** that do not have ***impenetrable understorey*** are required to be subject to a ***broad area habitat search***; and (b) the presence of ***impenetrable understorey*** must be recorded in the operational tracking records required by condition 39 of the ***approval*** and mapped in accordance with condition 117 of the ***approval***.
TARGETED FLORA SURVEYS		
20.3	**Targeted Flora Survey**	A ***targeted flora survey*** must be conducted in the ***operational area*** for each of the flora ***species*** listed in Part 3 and Part 4 of the tables in condition 31.2(2) (Appendix B) of **Protocol 31: Matters covered by the approval** if there is a ***record*** within five kilometres of the boundary of the ***operational area.*** Condition 20.3(1) does not apply to *Rhizanthella slateri (**species**)* and *Rhizanthella slateri* (***endangered population***). Prior to commencing a ***targeted flora survey***, ***FCNSW*** must: (a) document each ***species*** requiring survey under condition 20.3(1) above; (b) record the apparent location and extent of ***potential habitat*** for each of those ***species***; and (c) document the relevant survey season for each of those ***species.*** A ***targeted flora survey***: (a) must consist of a traverse searching for the ***species*** requiring survey under condition 20.3(1), at a maximum speed of one kilometre per hour;

Condition/Protocol	Topic	Requirements
		(b) must be carried out in the survey season (if any) identified in Part 3 or Part 4 of the tables in condition 31.2(2) of **Protocol 31:** **Matters covered by the approval** for the applicable ***species*** requiring survey under condition 20.3(1). (c) must be carried out in areas of ***potential habitat*** for the ***species*** requiring survey under condition 20.3(1) that are in the ***base net area*** and in areas up to 20 metres outside the ***base net area***; (d) where areas up to 10 hectares of ***potential habitat*** for one or more species for which the timing of the survey season coincide a minimum of a one-kilometre traverse is required; and (e) for each additional 10 hectares of ***potential habitat***, or part thereof above the initial 10 hectares, and additional 350 metres of traverse is required in addition to the survey effort set out in 20.3(4)(d) above. Notwithstanding condition 20.3(4)(c) above, a ***targeted flora survey*** is not required in areas more than 20 metres inside the boundary of any ***Environmentally Significant Area (ESA)**** that was in place at the time of the ***targeted flora survey***. Where there is a ***record*** of a ***species*** in the ***base net area*** or within 20 metres outside the ***base net area***, including a ***record*** made subsequent to a ***targeted flora survey*** set out in this ***protocol***, a minimum of 10 minutes additional search effort is required to be undertaken in surrounding areas of ***potential habitat*** for that ***species***. Where there are areas of ***impenetrable understorey*** which mean that the requirements of condition 20.3(4) and (6) cannot be met: (a) the maximum safe distance must be traversed; and (b) any allocated survey effort that was not able to be applied because of ***impenetrable understorey*** must be reallocated to additional traverses on the periphery of those ***impenetrable understorey*** areas; and (c) the presence of ***impenetrable understorey*** and the reallocated search effort required by condition 20.3(7)(b) must be recorded in the operational tracking records required by condition 39 of the ***approval***. Where consideration in 20.3(3) does not identify areas of ***potential habitat*** for a ***species***, ***FCNSW*** must either: (a) document why the ***operational area*** has no capacity to support the ***species*** and therefore ***survey*** is not required; or (b) spend a minimum of 15 minutes searching in the most suitable ***habitat*** areas for the ***species***.
TARGETED FAUNA SURVEYS		
20.4(2)	**Rufous Scrub-bird**	(a) A ***targeted fauna survey*** for Rufous Scrub-bird must be conducted as set out in this condition 20.4(2): (i) where there is Rufous Scrub-bird ***modelled habitat*** in an ***operational area***; or (ii) where there is a ***record*** of Rufous Scrub-bird in or within two kilometres of the boundary of an ***operational area***, (b) Surveys for Rufous Scrub-birds must be conducted: (i) in the ***base net area*** and within 100 metres of the ***base net area***; and

Condition/Protocol	Topic	Requirements
		(ii) between August and February at the rate of four survey sites per 50 hectares of ***Rufous Scrub-bird micro-habitat*** in the ***base net area***, with a minimum number of four survey sites where between one hectare and 50 hectares of ***Rufous Scrub-bird micro-habitat*** occurs in that area; and (iii) within or adjacent to areas of suitable ***Rufous Scrub-bird micro-habitat***. *Note: The **Rufous Scrub-bird micro-habitat** definition specifies these areas are one hectare or greater in size and so the requirement to survey only applies if at least one hectare of such **habitat** occurs in or within 100 metres of the **base net area**.* (c) At each survey site for Rufous Scrub-birds, the survey must consist of listening for calls of that ***species*** with a minimum duration of 10 minutes, repeated on two different days. (d) If a Rufous Scrub-birds survey cannot be carried out during the peak calling season (August to February), survey must be conducted at a rate of eight sites per 50 hectares of ***Rufous Scrub-bird micro-habitat*** in the ***base net area*** with a minimum number of eight survey sites where between one and 50 hectares of ***Rufous Scrub-bird microhabitat*** occurs in that area. (e) Each Rufous Scrub-birds survey must be conducted within or adjacent to areas of suitable ***Rufous Scrub-bird micro-habitat***.
20.4(3)	**Albert's Lyrebird**	(a) A ***targeted fauna survey*** for Albert's Lyrebird must be conducted as set out in this condition 20.4(3): (i) where there is 10 hectares or more of Albert's Lyrebird ***modelled habitat*** in an ***operational area***; or (ii) where there is a ***record*** of Albert's Lyrebird in or within two kilometres of the boundary of an ***operational area***. (b) Surveys for Albert's Lyrebird must be: (i) conducted in the ***base net area*** and within 100 metres of the ***base net area***; (ii) conducted in the early morning, giving attention to finding the location of nests; (iii) where there is Albert's Lyrebird ***modelled habitat*** in ***base net area***, or within 100 metres of the ***base net area***, surveys must be conducted at the rate of 15 minutes per 50 hectares or part thereof in the ***base net area***; (iv) where there is no Albert's Lyrebird ***modelled habitat*** in ***base net area,*** or within 100 metres of the ***base net area***, surveys must be conducted in or adjacent to areas within the vegetation formations, classes and types identified in the relevant ***species*** profile published by the Office of Environment and Heritage or identified by other literature if more relevant information exists; and (v) conducted with a minimum survey effort of one hour.
20.4(4)	**Marbled Frogmouth**	(a) A ***targeted fauna survey*** for Marbled Frogmouth must be conducted as set out in this condition 20.4(4): (i) where there is 10 hectares or more of Marbled Frogmouth ***modelled habitat*** in an ***operational area***; or (ii) there is a ***record*** of Marbled Frogmouth in or within two kilometres of the boundary of an ***operational area***, (b) Surveys for Marbled Frogmouth must:

Condition/Protocol	Topic	Requirements
		(i) consist of at least five minutes of call broadcast, being the playing of recorded Marbled Frogmouth call on a loudspeaker and 10 minutes of listening at the same site (a 'call playback site'); (ii) conducted the ***base net area*** in and within 100 metres of the ***base net area***; (iii) where there is Marbled Frogmouth ***modelled habitat*** in the ***base net area***, or within 100 metres of the ***base net area***, surveys must be conducted at the rate of: (iv) one call playback site for each 100 hectares of Marbled Frogmouth ***modelled habitat*** in the ***base net area*** with sites distributed across the Marbled Frogmouth ***modelled habitat*** in the ***base net area***; or (v) where less than 100 hectares of Marbled Frogmouth ***modelled habitat*** is present in that area, a minimum of one call playback site must be conducted; (vi) where there is no ***modelled habitat*** in the ***base net area***, or within 100 metres of the ***base net area***, the call playback site must be undertaken in or adjacent to areas within the vegetation formations, classes and types identified in the relevant ***species*** profile published by the Office of Environment and Heritage or identified by other literature if more relevant information exists.
20.4(5)	***Assa darlingtoni* (Southern meta-population)**	(a) A ***targeted fauna survey*** for *Assa darlingtoni* must be conducted as set out in this condition 20.4(5): (i) where there is 10 hectares or more of *Assa darlingtoni* ***modelled habitat*** in an ***operational area***; or (ii) where there is a ***record*** of *Assa darlingtoni* in or within two kilometres of the boundary of the ***operational area***. (b) Surveys for *Assa darlingtoni* must be: (i) conducted in and within 50 metres of the ***base net area***; (ii) where there is *Assa darlingtoni* ***modelled habitat*** in the ***base net area***, or within 50 metres of the ***base net area***, conducted at a rate of 10 minutes for each 50 hectares in the ***base net area***; (iii) where there is no *Assa darlingtoni* ***modelled habitat*** in the ***base net area***, or within 50 metres of the ***base net area***, surveys must be conducted in or adjacent to areas within the vegetation formations, classes and types identified in the relevant ***species*** profile published by the Office of Environment and Heritage or identified by other literature if more relevant information exists; (iv) conducted for a minimum of 30 minutes per survey; and (v) conducted each with a 10-minute survey period with at least two minutes of call broadcast, unless the ***species*** is calling freely. (c) Surveys must assess a range of ***soaks and seepages*** and ***drainage features*** within *Assa darlingtoni* ***modelled habitat*** in the ***operational area***. (d) Surveys must only be conducted between 1 August and 31 March and during periods of ***likely high-calling activity***.
20.4(6)	***Philoria* species**	(a) A ***targeted fauna survey*** for *Philoria* species must be conducted as set out in this condition 20.4(6): (i) where there is 10 hectares or more of *Philoria* spp. ***modelled habitat*** in an ***operational area***; or (ii) where there is a ***record*** of *Philoria* spp. in or within two kilometres of the boundary of the ***operational area***.

Condition/Protocol	Topic	Requirements
		(b) Surveys for *Philoria* species must be: (i) conducted in and within 50 metres of the ***base net area***; (ii) where there is *Philoria* spp. ***modelled habitat*** in the ***base net area***, or within 50 metres of the ***base net area***, surveys must be conducted at a rate of 10 minutes for each 50 hectares in the ***base net area***; (iii) where there is no *Philoria* spp. ***modelled habitat*** in the ***base net area***, or within 50 metres of the ***base net area***, surveys must conducted in or adjacent to areas within the vegetation formations, classes and types identified in the relevant ***species*** profile published by the Office of Environment and Heritage or identified by other literature if more relevant information exists; (iv) for a minimum of 30 minutes per survey; and (v) each with a 10-minute survey period with at least two minutes of call broadcast, unless the ***species*** is calling freely. (c) Surveys must assess a range of ***soaks and seepages*** and ***drainage features*** within *Philoria* spp. ***modelled habitat*** in the ***operational area***. (d) Surveys must only be conducted between 1 August and 31 March and be conducted during periods of ***likely high-calling activity***.
	Northern Corroboree Frog	(a) A ***targeted fauna survey*** for Northern Corroboree Frog must be conducted in each ***operational area*** with Northern Corroboree Frog ***modelled habitat*** in Bondo and Micalong ***State Forests*** and: (b) A ***targeted fauna survey*** for Northern Corroboree Frog must consist of the shout response technique, being a loud shout conducted every five metres followed by a 30- second listening period around ***bogs*** and ponds with Northern Corroboree Frog ***modelled habitat*** in and within 30 metres of the ***base net area***. (c) Surveys for Northern Corroboree Frog must be conducted between 14 February and 15 March in the daytime when weather conditions are fine.
20.4(8)	**Hastings River Mouse habitat suitability assessment**	(a) ***Habitat*** suitability assessment or equivalent rapid ***habitat*** assessment for Hastings River Mouse must be conducted in the ***base net area***, and within 200 metres of the ***base net area***, where there is 10 hectares or more of Hastings River Mouse ***modelled habitat*** in the ***operational area*** or a ***record*** of Hastings River Mouse in or within 200 metres of the ***operational area***. (b) The assessment required under this condition 20.4(8) must be carried out as set out below: (i) Classify and map vegetation cover using aerial photographs, other remote-sensing technology or existing mapped information such as forest type maps. The vegetation should be classified into broad vegetation categories, such as ***rainforest***, wet sclerophyll, dry sclerophyll, woodland and grassland. (ii) Each broad vegetation category must be inspected in the field and the following types of vegetation must be mapped at a scale of 1:25,000 or better: (A) wet or dry sclerophyll forests with a grass, sedge, rush, heath or fern understorey; (B) woodland with a grass, sedge, rush, heath or fern understorey; and

Condition/Protocol	Topic	Requirements
		(C) wet or dry sclerophyll forest or woodland with dispersed patches of grass, sedge, rush, heath or fern. (iii) Topographic maps, aerial photographs, other remote-sensing technology and field survey must be used to identify and map any areas with outcropping rock cover occurring in conjunction with vegetation types in condition 20.4(8)(b)(ii) of this ***protocol***. (iv) For every 10 hectares of vegetation type mapped in condition 20.4(8)(b)(ii), one 100 metres microhabitat transect must be established and the assessment identified in condition 20.4(8)(c) made along each transect. (v) Each microhabitat transect must be located to sample a representative area within each 10-hectare patch of vegetation type and within 100 metres of outcropping rock cover referred to in condition 20.4(8)(b)(iii) of this ***protocol*** where present. (vi) Each microhabitat transect must, where possible, be orientated parallel to ***drainage lines*** or transects and sample areas of high total vegetation cover of sedges, rushes, grass, heath and fern. (vii) Where mapped vegetation type is patchy in distribution, each patch greater than five hectares must be sampled. (c) A 'microhabitat transect' as referred to in condition 20.4(8)(b)(viii) of this ***protocol*** means a survey comprising of the assessment of the following: (i) sedge, rush, grass, heath and fern cover (GSRC), must be determined by: (A) calculating the percentage cover of these vegetation types in a 3-metre radius plot; (B) sampling plots at 10 metre intervals along a 100 metre long transect; and (C) calculating the average percentage of cover of these vegetation types of the 11 plots sampled. (ii) Vegetation cover (VC), must be determined by: (A) calculating the average number of times vegetation contacts a one centimetre diameter pole between the height of 10 and 75 centimetres above ground orientated vertical; (B) sampling at one point in each of the plots described in 20.4(8)(c)(i); and (C) calculating the average number of contacts across the 11 plots sampled. (iii) Heath cover (HC), must be determined by: (A) recording the presence of heath ***plants*** of the genera *Leucopogon, Epacris, Oxylobium, Pultenaea, Daviesia, Dillwynia, Hakea, Baeckea* and *Callistemon* along the length of the transect described in 20.4(8)(c)(i)(B). (iv) Shelter index (SI) must be determined by counting the following within 20 metres each side of the transect described in 20.4(8)(c)(i)(B): (A) the number of natural burrows (being individual holes four centimetres or greater in diameter and 30 centimetres or greater deep) up to a maximum of 40; (B) the number of large trees with basal cavities being (holes in the base of trees that are four centimetres or greater in diameter and 30 centimetres or greater deep); (C) the number of rock cavities (being individual holes four centimetres or greater in diameter and 30 centimetres or greater deep) up to a maximum of 40;

Condition/Protocol	Topic	Requirements
		(D) the number of logs that are 30 centimetres or greater in diameter; and (E) calculating the sum of (A), (B), (C) and (D) and dividing that by four. (v) The presence of any outcropping rock cover that is more than 100 in length and within 500 metres of the transect; (d) Other than for a rapid ***habitat*** assessment, information collected in microhabitat transects for Hastings River Mouse referred to in 20.4(8)(c) above must be applied to Table 2 below, and using the models that follow it, the suitability of ***habitat*** must be determined as either: (i) unsuitable, moderate or high suitability using model 1; or (ii) unsuitable, moderate or high suitability using model 2. (e) Where ***FCNSW*** undertakes a rapid ***habitat*** assessment approach for Hastings River Mouse: (i) ***FCNSW*** must record and report all information in the form and manner approved in writing by the ***EPA*** for rapid ***habitat*** assessments for Hastings River Mouse; (ii) any staff using this approach must be trained in the use of the method; (iii) the method must be subject to regular calibration by ***FCNSW***; and (iv) any assessment for Hastings River Mouse under this condition 20.4(8) using this approach must be documented. (f) In an ***operational area*** in which an assessment under this condition 20.4(8) is required, the assessment must be completed prior to the commencement of any ***pre-harvest burn***. (g) Where ***habitat*** is assessed as of moderate or high suitability, **the targeted surveys** in condition 20.4(8)(h) below must be implemented within such ***habitat***. (h) Hastings River Mouse trapping surveys (i) Where a Hastings River Mouse ***habitat*** suitability assessment carried out under condition 20.4(8)(a) identified 10 hectares or more of ***Hastings River Mouse micro-habitat*** in and within 200 metres of the ***base net area***, surveys for Hastings River Mouse must be conducted in and within 200 metres of the ***base net area*** at the rate of transects of 25 traps for each 25 hectares of ***Hastings River Mouse micro-habitat*** in the ***base net area***, with a minimum effort of 50 traps. (ii) When conducting a Hastings River Mouse survey, traps must be placed for a minimum of four nights. (iii) When conducting a Hastings River Mouse survey, transects must be distributed throughout the available ***Hastings River Mouse micro-habitat***, with traps placed about 10 metres apart on transects in best available ***Hastings River Mouse micro-habitat*** along the transect.
20.4(9)	**Koala**	(a) Prior to the commencement of any ***forestry operations*** in a ***local landscape area***, a ***targeted fauna survey*** for Koalas consistent with either condition 20.4(9)(c) or 20.4(9)(d) below must be undertaken across ***local landscape areas*** that include parts of the following areas in the ***Southern Subregion*** or ***Eden Subregion***: (i) Tallaganda, Badja, Dampier, Moruya, Wandella and Bodalla ***State Forests*** in the ***Southern Subregion***; and (ii) Glenbog and Glen Allen ***State Forests*** in the ***Eden Subregion***; and

Condition/Protocol	Topic	Requirements
		(iii) outside of the ***State Forests*** listed in conditions 20.4(9)(a)(i) and 20.4(9)(a)(ii) above, any ***local landscape areas*** in the ***Southern Subregion*** or ***Eden Subregion*** where a Koala ***record*** occurs in or within two kilometres of the ***local landscape area*** in the last 10 years. (b) Koala surveys required under this condition may be conducted as either a Koala RGbSAT survey as set out in condition 20.4(9)(c) below, or a quality acoustic recording device survey as set out in condition 20.4(9)(d) below. (c) Where FCNSW elect to undertake a Koala RGbSAT survey, the survey must: (i) be undertaken at regular intervals identified by a one-kilometre grid; (ii) identify at each survey grid point a 'centre tree' which is considered to be among the most suitable trees in the area for Koala use and must be a ***Koala browse tree*** (where these are available); (iii) have the centre tree located within 100 metres from the identified grid point in order to avoid cleared areas, boundaries or ***habitat*** disturbances and to maximise the inclusion of the most suitable trees in the area for Koala use, prioritising ***Koala browse trees***, in the sample; (iv) record the spatial location of the centre tree; (v) ensure that the centre tree and a minimum of 29 surrounding trees (which must not be a palm, cycad, fern or *Xanthorrhea* spp.) with a minimum ***diameter at breast height (DBH)*** of 100 millimetres must be marked in the field, the tree ***species*** and diameter recorded and the tree sampled for Koala use as follows: (A) a minimum of two minutes must be spent searching the base of each tree for Koala faecal pellets, including an initial cursory inspection of the ground surface within a distance of 100 centimetres from the base of the tree, followed by a more thorough inspection involving disturbance of the leaf litter and ground cover within 100 centimetres of the base of the tree; (B) once a single faecal pellet is identified beneath a tree the search around that tree may cease, a ***record*** must be made of the Koala faecal pellet including the spatial location recorded; and (C) the detail of the search effort is recorded to demonstrate compliance with condition 20.4(9)(v). (vi) at each survey grid point, assess and record the following: (A) indication of the apparent age of any Koala faecal pellets; (B) soil fertility; (C) overstorey description; (D) understorey description; (E) ***groundcover*** percentage; (F) distance from the centre tree to furthest (30th) tree; (G) any observations of Koalas or other signs of Koala use such as scratchings on bark of trees; and (H) if ***evidence of Koala*** is identified within a one-kilometre grid site, surrounding sites based on a 500-metre grid must be surveyed. (d) Where ***FCNSW*** have elected to carry out a quality acoustic recording devices Koala survey, it must be conducted as follows:

Condition/Protocol	Topic	Requirements
		(i) survey sites are undertaken at semi-regular intervals at a rate of one site for each 100 hectares of the ***local landscape area*** arranged so that the sites are located: (A) at least 750 metres apart and no more than 1.25 kilometres apart; and, (B) in the vicinity of known ***koala browse tree species*** where they occur; (ii) at each survey site, a quality acoustic recording device is deployed to record for a minimum of five nights with less than 2 mm of overnight rainfall per night; (iii) the quality acoustic recording device are deployed in the period from mid-October to mid-December; and (iv) recordings obtained are scanned by acoustic software and a Koala recogniser with computer identified Koala bellows being verified by manual checking of recording. (In addition note Condition 75)
RECORDING OF SURVEYS		
20.5	**Recording of surveys**	A tracklog of all ***broad area habitat searches*** and ***targeted flora surveys*** and ***targeted fauna surveys*** must be mapped in accordance with condition 117 of the ***approval***. Each search and survey conducted under this ***protocol*** must record: (a) who carried out the survey; (b) the date the survey was conducted; (c) the start and finish times of the search; (d) any ***threatened species*** or ***subject species*** detected; (e) any ***habitat features*** detected; and (f) searches in and around ***impenetrable understorey*** areas. All recorded ***threatened species***, ***subject species*** and ***habitat features*** must be mapped in accordance with condition 117 of the ***approval***. For flora or fauna ***threatened species***, ***subject species*** and ***habitat features*** that are cryptic or difficult to locate in the field, their location must also be marked with flagging tape to ensure their protection. All recorded ***threatened species***, ***subject species*** and ***habitat features*** are immediately subject to any relevant requirements relating to those ***threatened species***, ***subject species*** and ***habitat features*** in the ***approval***. All recorded ***threatened species, subject species*** and ***habitat features*** that trigger an ***ESA*** or protection under the ***approval*** must be displayed on an ***operational map***. When ***FCNSW*** is required to make a ***record*** of a ***habitat feature*** relating to a ***threatened species*** or ***subject species*** that requires protection under the ***approval***, this ***record*** must include documentation of the nature of the ***record*** such as it being a nest, roost, den, camp, burrow or other observation type.
Tree retention - Koalas		
23.1 (4)	**Tree retention**	In the ***Upper North East Subregion*** and the ***Lower North East Subregion:***

Condition/Protocol	Topic	Requirements
		(a) the ***Koala browse tree*** retention rates within each ***patch*** must be determined from the area weighted average of ***Koala browse prescription 1*** and ***Koala browse prescription 2*** areas within the ***base net area*** of the ***patch***; (b) where a ***patch*** includes areas of ***Koala browse prescription 1*** and areas that have no mapped koala browse prescription, then ***Koala browse prescription 1*** must apply across the ***patch***; (c) Tallowwood (*E. microcorys*), Swamp Mahogany (*E. robusta*) and Red Gums (*E. tereticornis*, *glaucina*, *seeana* and hybrids) must be prioritised for retention when applying the ***Koala browse prescription 1*** or ***Koala browse prescription 2*** and must make up at least 50 per cent of the retained ***Koala browse trees*** where these are available; and (d) where more than the minimum number of ***Koala browse trees*** are available for retention in the relevant area of a ***patch***, trees must be scattered across the relevant area of the ***patch.***
OWLS - Identification of large forest owlexclusion zones on unassessed land		
26.2	**OWLS - Identification of large forest owl exclusion zones on unassessed land#**	Where there is a ***record*** of a large forest owl ***species***, being Powerful Owl, Masked Owl, Sooty Owl or Barking Owl, within an ***operational area*** which contains ***unassessed Crown-timber land*** or within two kilometres outside the boundary of the ***operational area*** which contains ***unassessed Crown-timber land***, ***FCNSW*** must identify ***large forest owl exclusion zones*** using one of the following approaches: (a) ***FCNSW*** may produce planning documentation to identify ***large forest owl exclusion zones*** meeting protections identified as 'Large Forest Owl Landscape Approach' in the ***relevant IFOA*** in place prior to the ***commencement of the approval***; or (b) *w*here a planning area of less than 1,000 hectares is available to apply condition 26.1(1)(a), a minimum of 20 per cent of the ***operational area*** must be identified as ***large forest owl exclusion zones*** as set out in condition 26.3. 26.3 Composition of large forest owl exclusion zones The areas identified as ***large forest owl exclusion zones*** in condition 26.2(1) above must include as much ***modelled habitat*** as possible or the large forest owl ***species*** that have a ***record*** in the ***operational area*** or within two kilometres outside the boundary of the ***operational area***. Where less than 20 per cent of the ***operational area*** is ***modelled habitat*** for large forest owl ***species*** then areas of ***high conservation value old growth forest*** that are not otherwise ***modelled habitat*** for large forest owl ***species*** can be included within the required as ***large forest owl exclusion zones.*** Where less than 20 per cent of the ***operational area*** has been identified by conditions 26.3(1) and 26.3(2) above, the remaining area must be identified in parts of the ***operational area*** which are most consistent with the ***habitat*** described in the relevant species profile published by the Office of Environment and Heritage and relevant literature. The areas of ***large forest owl exclusion zones*** identified may overlap with other ***ESAs*** provided they are consistent with conditions 26.3(1), 26.3(2) and 26.3(3) above.

*See ESA descriptions in Division 3 ESAs, page 19-22 in CIFOA Conditions. Includes large forest owl exclusion zones.

[#] An area of other ***Crown-timber land*** that has not previously been subject to a relevant assessment and/or planning process to identify any areas of ***high conservation value old growth forest***, ***rainforest***, ***large forest owl exclusion zones*** or ***ridge and headwater habitat*** (as the case may be) that may occur within it.

Appendix C2. Habitat features covered in broad area habitat searches (from (Natural Resources Commission, 2020a) see Table 2, Condition 57 in (State of New South Wales and Environment Protection Authority, 2018))

Habitat Feature or species that must be searched for during broad area habitat searches
Nest, roost or den trees (as listed in Table 4 chapter 4 of the approval) Page 33-34 of Conditions document.
Stick nests greater than 50cm in diameter
Bat roost trees and potential subterranean bat roosts
Flying fox camps
Glossy black cockatoo feed tree
Glider sap feed trees
Wetlands
Rock outcrops and cliffs
Heath and scrub
Koalas, and evidence of Koalas
Soaks and seepages in *Assa darlingtoni* modelled habitat, *Philoria* modelled habitat and where there is a record of *Philoria* or *Assa darlingtoni* within two kilometres of the operational area
Hollow bearing trees and nectar trees
Spotted tail quoll dens (including maternal dens)
Spotted tail quoll latrine sites
Bare nosed wombat burrows (Northern population management area)
Flora species listed in part 3 and 4 of the condition 31.2 of Protocol 31 recorded within five kilometres of the boundary of the operational area where potential habitat (*Protocol 39 and DPE Species profiles)* occurs within the operational area.
Evidence of any other subject species
Evidence of any other habitat feature that requires protection under the approval.