Check for updates

Received: 6 June 2024 | Revised: 8 May 2025 | Accepted: 25 May 2025

DOI: 10.1111/csp2.70089

CONTRIBUTED PAPER

Conservation Science and Practice
A journal of the Society for Conservation Biology
Open Access

WILEY

Have significant biodiversity values been protected from industrial logging across Australia?

Chris Taylor[1] | **Kita Ashman**[1,2] | **Michelle Ward**[3,4] | **Hugh Possingham**[4] | **David B. Lindenmayer**[1]

[1]Fenner School of Environment and Society, The Australian National University, Canberra, Australian Capital Territory, Australia

[2]WWF-Australia, Melbourne, Victoria, Australia

[3]Centre for Planetary Health and Food Security, Griffith University, Nathan, Queensland, Australia

[4]Centre for Biodiversity and Conservation Science, The University of Queensland, St Lucia, Queensland, Australia

Correspondence
David B. Lindenmayer, Fenner School of Environment and Society, The Australian National University, Canberra, ACT 2601, Australia.
Email: david.lindenmayer@anu.edu.au

Abstract

Much of the planet's forest biodiversity is at risk from a range of threats. Threats include gaps in the protected area network and instances where these gaps are subject to intensive industrial logging. These gaps are referred to as optimal areas for protection and we sought to determine if certification schemes maintained the environmental values of these areas across Australia. To do this, we identified gaps within the existing protected area network across Australia that were optimal areas for protecting forest- and woodland-dependent species of national environmental significance. We intersected our results with spatial records of logging between 2007 and 2023 in the Australian states of Victoria and New South Wales that have been awarded certification under the Responsible Wood scheme. We found a large proportion of logging in Victoria and New South Wales occurred within high scoring optimal areas for protecting species of national environmental significance. We conclude that certification schemes are likely failing to meet their stated objectives to adequately maintain the environmental values of optimal areas for protection from the most intensive forms of logging. Reform of Australia's certification schemes and a significant expansion of protected forest areas is urgently needed.

KEYWORDS

conservation effectiveness, forestry operations, logging impacts, protected areas, threatened biodiversity, timber certification schemes

1 | INTRODUCTION

The world's forests and woodlands are home to approximately 80% of all the planet's plant and animal diversity (United Nations, 2023). Yet current estimates are that more than 1 million species globally, including many forest-associated taxa, are at risk of extinction (Intergovernmental Science-policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019). Losses of biodiversity are a major form of global change (Steffen et al., 2015) that will have substantial impacts on ecosystem processes and services, as well as the economic well-being of humanity. The World Economic Forum has estimated that 44% of the world's Gross Domestic Product

(GDP) could be severely impacted by the loss of biodiversity (World Economic Forum, 2023).

There are many drivers of species loss in forests, including land clearing, hunting, invasive species, climate change, and logging (Lindenmayer & Franklin, 2002; Maxwell et al., 2016). Several studies have demonstrated the critical importance of intact areas for forest biodiversity conservation, such as fully protected environments where some (although not all) of these threatening processes do not occur (e.g., Gibson et al., 2011, reviewed by Watson et al., 2018). Protected areas have long been the cornerstone of effective conservation efforts (Kirkpatrick, 1983; Margules & Pressey, 2000; Visconti et al., 2019). They have been credited with conserving considerable amounts of biodiversity (Lunney et al., 2018), with populations of many plant and animal species being larger inside reserves than outside them (e.g., Coetzee et al., 2014). However, protected areas cover around only 726 million ha or 18% of global forest cover (FAO, 2020). Studies have shown that significant gaps exist within the reserve network, with numerous species failing to meet their representation targets in reserves (Dinerstein et al., 2024).

In Australia, there has been a strong focus on the importance for protected areas to be Comprehensive, Adequate, and Representative (Commonwealth of Australia, 1999). However, existing protected areas typically contain a biased sample of biodiversity, where reserve selection was focused on land not considered valuable for agriculture, forestry, or urban development (Lindenmayer & Burgman, 2005). This has resulted in the current network meeting adequacy targets for fewer species compared with spatially optimized models of reserve selection (Watson et al., 2011). While the existing reserve system captures some optimal areas for protecting species, other such areas remain outside the existing reserve system and can be subject to land use conflicts (Lindenmayer & Taylor, 2023). This highlights the importance of off-reserve areas for optimal areas for protecting forest- and woodland-dependent species (Lindenmayer & Franklin, 2002).

Across some Australian states, off-reserve areas of forest have been subject to extensive and intensive logging operations for over a century (Dargavel, 1995; Griffiths, 2002; Moulds, 1991) which can undermine their conservation values. There have been efforts to protect off-reserve areas with high conservation values in an expanded reserve network (Clode, 2006; LCC, 1994). However, there has been resistance to formally protecting these areas as they are valued by the logging industry (AFPA NSW, 2021; Freeman, 2023). Moreover, it has been argued that codes of forest practice and other forms of regulation of forestry operations can complement the reserve system by managing biodiversity outside formal reserves (Munks et al., 2020; NCE and Indufor, 2022).

One means of assessing the viability of species in off-reserve wood production forests is through assessments against approved standards under different forest certification schemes. Almost all of Australia's off-reserve forest areas allocated to logging operations have been certified under the Forest Stewardship Council (FSC) and/or Responsible Wood forest certification schemes, equating to more than 20 million ha in 2023 (ABARES, 2023). Forest certification emerged during the 1990s as a voluntary market-based mechanism to provide market assurance that environmental, social, and economic values of forests subject to wood production were being protected, maintained or enhanced (Nussbaum & Simula, 2005). Assurances that environmental values were being protected, maintained or enhanced include those of high conservation value and significant biodiversity values (FSC Australia, 2019; Responsible Wood, 2021). The FSC and Responsible Wood schemes, define "high conservation value" and "significant biodiversity value" as being present (respectively) when there are occurrences of rare or threatened species as well as a range of other environmental values (FSC Australia, 2019; Responsible Wood, 2021). The two standards require certified forest management enterprises to maintain or enhance these values.

In this paper, we quantified the potential for spatial overlap between logging operations and optimal areas for species protection in the wood production forests of Australia. Such analyses are important given that Australia is characterized by extensive past and present deforestation (Bradshaw, 2012; WWF Australia, 2023), as well as high levels of species loss and a large number of threatened species (Legge et al., 2023). We asked: *What is the extent of forests and woodlands containing optimal areas for forest- and woodland-dependent species outside of protected areas across Australia*? To answer this question, we intersected data on the predicted occurrence of threatened forest-dependent and woodland-dependent species with available spatial data on forest and woodland areas that are located within formal protected areas and those outside the protected area network. There are substantial areas of forest and woodlands outside the protected area network subject to industrial logging, particularly in two Australian states where data on native forest logging operations are available: New South Wales and Victoria. Importantly, forest certification schemes (sensu Nussbaum & Simula, 2005) are designed to maintain or enhance significant conservation values outside of protected areas (Zwerts et al., 2024), including those under the Responsible Wood standards in Australia. On this basis, a second key question which motivated this study was: *Have forest and woodland areas that had been covered by forest certification schemes and that supported optimal areas for forest- and woodland-dependent species been subjected to intensive logging operations*?

Understanding the potential for spatial conflict between logging operations and optimal areas for forest- and woodland-dependent species is critical for developing effective conservation strategies, including prioritizing areas for future protection as formal reserves (Taylor & Lindenmayer, 2019). Given this, the analyses presented here will inform policies not only for forest management and forest biodiversity conservation, but also for forest certification schemes designed to ensure that logging operations are conducted on an ecologically sustainable basis (FSC, 2021; Newsom et al., 2006; PEFC, 2022; Zwerts et al., 2024).

2 | METHODS

2.1 | Study area

We conducted our analysis of optimal areas for protecting forest-dependent species on mapped native forests across Australia as presented in the Australia State of the Forest Report 2023 (Figure 1). However, our analysis of logging operations across our identified optimal areas for forest- and woodland-dependent species was limited to New South Wales and Victoria, where spatial data for historic logging activities are available (DJPR, 2023; Forestry Corporation of NSW, 2024). Historic logging data were not publicly available for Tasmania, Queensland, or Western Australia. There is no logging of native forest on public land in Northern Territory, South Australia, and the Australian Capital Territory.

The State of the Forest Report classifies Australia's forests into three broad categories: Native Forest, Commercial Plantations, and Other Forests. The Native Forest category comprises areas dominated by native tree species across their natural ranges and defined by their dominant tree species or forest structure. This category includes forests dominated by *Acacia*, *Callitris*, *Casuarina*, *Eucalyptus*, *Melaleuca*, mangroves, rainforest and other native forest types (Department of Agriculture Fisheries and Forestry, 2023b). Native forests span 131.5 million ha across Australia, representing 98% of Australia's overall forest cover (Department of Agriculture Fisheries and Forestry, 2023b). Of this, approximately 22 million ha of Australia's forests are in formal conservation reserves and 27.4 million ha of Australia's forests are available for, and considered suitable for, commercial logging operations (Department of Agriculture Fisheries and Forestry, 2024).

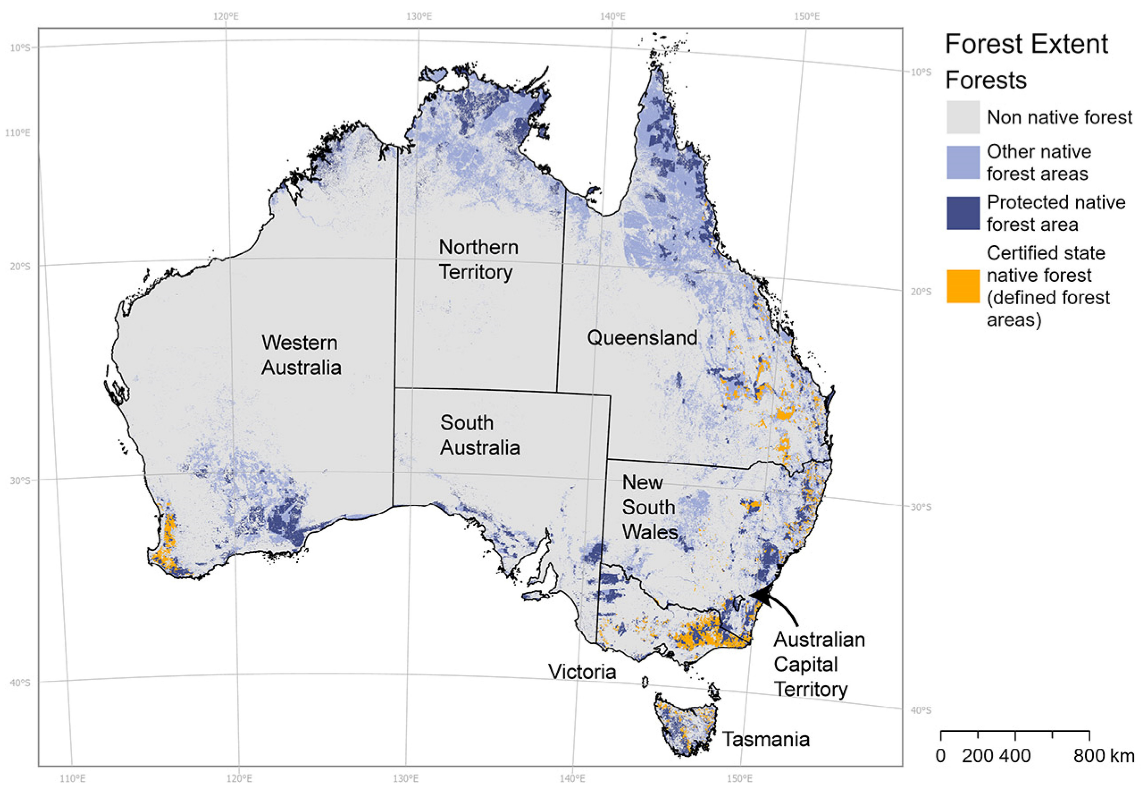

FIGURE 1 Extent of native forest across Australia with state native forests (defined forest areas) certified under the Responsible Wood Scheme and IUCN protected native forest areas I–VI. *Source*: DAFF (2023a).

Our analysis of optimal areas for conservation encompassed all native forest across all land tenures across Australia, including native forest in nature conservation reserves, state forests, and private land (Department of Agriculture Fisheries and Forestry, 2023c). We excluded commercial plantations, including hardwood and softwood plantations, as well as the "Other Forest" category, which consists of mostly of non-commercial plantations and planted forests of various types.

2.2 | Protected areas in Australia

As of 30 June 2022, Australia's National Reserve System covered 22.1% of the country's land mass, equating to nearly 170 million ha across 13,903 protected areas (DCCEEW, 2023). This is inclusive of IUCN protected area categories I-VI, which includes formal conservation reserves as well as other protected area types. These protected areas feature nearly 37 million ha mapped as native forest in the Australian State of the Forests report (Department of Agriculture Fisheries and Forestry, 2024). The IUCN protected area system covers six categories: strict nature reserves or wilderness parks, national parks, natural monuments or features, habitat/species management areas, protected landscapes or seascapes and protected areas with sustainable use of natural resources (Dudley, 2008). These include Indigenous Protected Areas (IPAs), which consist of 9.2 million ha of forests or 25% of the total protected native forest area. Protected areas classified as IUCN Category II, including national parks, represent the largest share of protected native forest, covering ~16 million ha or 43% of the total. The next largest category is IUCN Category VI, ecompassing ~10 million ha. The average size of protected land areas across Australia's protected areas is 15,491 ha, with a standard deviation of 220,153 ha, highlighting a substantial variability in protected area sizes. This reflects a system comprising both extensive landscape-scale protected areas and smaller, often fragmented areas. All IUCN protected area categories exclude industrial logging and other forms of large-scale and intensive resource extraction. Data for protected areas used in our analysis were sourced from the Collaborative Australian Protected Areas Database (DCCEEW, 2023).

2.3 | Responsible Wood forest certification

The two forest certification schemes operating in Australia are the Forest Stewardship Council (FSC) and the Responsible Wood certification schemes, of which the latter is endorsed by the Programme for the Endorsement of Forest Certification (PEFC) (Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee, 2018). In terms of area, the Responsible Wood certification scheme is the larger of the two, with 20.4 million ha certified under the scheme in 2023 (Responsible Wood, 2024a). In comparison, the FSC had certified approximately 1.2 million ha of forests and plantations (FSC, 2024; PEFC, 2023). Most areas certified under the Responsible Wood scheme consist of native forests (Responsible Wood, 2024a). As our study examined optimal areas for protecting forest- and woodland-dependent species in native forests, we focused on native forests certified under the Responsible Wood standard.

All the state-owned forestry enterprises across Australia were awarded certification under the Responsible Wood forest management standard by 2023 (Table S1, Supporting Information). These enterprises include Sustainable Timber Tasmania (formally Forestry Tasmania), VicForests, Forestry Corporation NSW, DAF Forestry, Forest Products Commission WA, and Forestry SA. The combined certified area managed by these state-owned enterprises is 18.9 million ha or 93% of the total area certified under Responsible Wood (Responsible Wood, 2024b) (Table S1). Most of the certified area under these enterprises is native forest. We note that native forest logging was recently halted in Western Australia and Victoria. The Responsible Wood standard covers forest management performance requirements for a defined forest area that is subject to certification under this standard. The standard is intended for voluntary application to any forest area being managed in Australia or New Zealand for the extraction of forest products and forest services, whether from native forests or plantations (Standards Australia, 2021). The Responsible Wood forest management standard consists of criteria that specify the normative requirements for forest management enterprises to comply with to attain certification. It covers aspects of cultural, economic, environmental, and social values of forests, as well as management system requirements (Standards Australia, 2021).

A critical component of forest certification is the identification, maintenance, and enhancement of threatened species occurrence and distribution (Matias et al., 2024). In seeking to address the needs of threatened species, the Responsible Wood standard features criteria on *significant biodiversity values*, which includes "known or likely occurrences of threatened species and their known or potential habitat" and "areas with regionally or nationally significant concentrations of native species at risk from current, planned or potential management activities" (Standards Australia, 2021, p. 29).

The current Responsible Wood Standard requires that certified forest management enterprises: "*identify significant biodiversity values (SBVs) that are within and/or ecologically connected to the defined forest area* and *develop and implement effective strategies to maintain, or enhance SBVs, including the control of potential adverse impacts*" (Standards Australia, 2021, p. 52). The Responsible Wood standard advises that: "*regulatory frameworks, recognised databases, published scientific information, expert knowledge and current research, complemented as needed by inventory and mapping of forest resources, field assessments and other relevant forest planning instruments…*," can be used in the identification of *significant biodiversity values* and that identification of *significant biodiversity values* in the vicinity of the certified forest area can involve a desktop assessment of recognized databases (Standards Australia, 2021, p. 52). The requirement for forest management to implement practices that maintain and protect significant biodiversity values has remained consistent through several revisions of the Responsible Wood standard (see Table S2).

2.4 | Forest and woodland species of national environmental significance

In our study, we sought to identify optimal areas for protecting forest-dependent species by examining *species of national environmental significance* (SNES) across Australia under the Environment Protection and Biodiversity Conservation Act 1999. We contend that this database would qualify as a *recognized database* as per the Responsible Wood standard (Standards Australia, 2021, p. 52). These datasets were produced by spatial ecologists in the Australian Department of Climate Change, Energy, the Environment and Water (2024), where they used modeling software and environmental data to create distributions that mapped the known and predicted occurrence areas of EPBC Act-listed species, including potential habitats. However, the Australian Department of Climate Change, Energy, the Environment and Water (DCCEEW, 2024) advise that these data are indicative rather than definitive, and they are a starting point for further investigation rather than the outcome of a comprehensive scientific assessment.

The species of national environmental significance lists 738 animal species and 1435 plant species (DCCEEW, 2024). There are two categories of species designation rank: (1) Species or species habitat likely to occur. And, (2) Species or species habitat may occur. We selected data under the "Species or species habitat likely to occur" category as the "may occur" areas are too broad to clearly identify significant biodiversity value areas. This provided a database of 2173 listed species' distributions. As our study focused on native forest and woodland areas, we selected those species of national environmental significance that are forest-dependent and/or woodland-dependent. In undertaking this work, we assessed species by reviewing their respective EPBC Act Recovery Plans (where available) to determine whether a species is forest-dependent or woodland-dependent. This was done by reviewing the distribution and habitat requirements for each species as detailed in each recovery plan listed under the EBPC Act 1999. For example, we reviewed the Leadbeater's Possum Recovery Plan, which states that the current habitat of the species occurs in montane ash forest, along with sub-alpine woodland and lowland swamp forest, hence it is a forest and woodland-dependent species. We excluded species endemic to island territories, inclusive of Christmas Island, Lord Howe Island and Norfolk Island. This process resulted in 688 species being identified and subsequently selected for our analysis. These taxa comprised 42 species of birds, 23 species of frogs, 36 species of mammals, 16 species of reptiles, and 571 species of vascular plants. Of these 688 selected species, 16%, 40%, and 43% are listed as critically endangered, endangered and vulnerable, respectively. We provide a list of these species in Table S3.

The SNES data were in the form of shapefiles containing polygons. Using Model Builder in ArcGIS Pro (ESRI, 2022), we clipped each SNES species shapefile to the land areas of Australia (excluding Christmas Island, Lord Howe Island, and Norfolk Island) and converted these shapefiles to rasters at a resolution of 500 m $\times$ 500 m grid cells. We assigned raster cells with the likely distribution of SNES listed species with their listed species ID number (Table S3); areas absent of distribution were assigned a zero value.

2.5 | Identifying optimal areas for the protection of forest-dependent species across Australia

We used Marxan to identify optimal areas for the protection of forest-dependent and woodland-dependent species of national environmental significance. Marxan uses a simulated annealing algorithm to select multiple areas that meet priority species targets or ecosystem targets while minimizing costs (Ball et al., 2009). Marxan analyses use a grid of "planning units" that divides the area of interest into smaller units. The information that is used for each planning unit includes: the amount of any mappable species or habitat type, the proximity of other planning units, and the cost/benefit of prioritizing a particular planning unit for conservation, which was set in this case to the area of each planning unit (Serra-Sogas et al., 2020). Our planning units for Marxan consisted primarily of 25 km^2 hexagonal shaped planning units across Australia. Smaller planning units occurred where they intersected with geographical land boundaries or along protected area boundaries. This resulted in the generation of 351,540 planning units. We selected planning units for analysis that consisted of greater than 10% of their respective areas being that of native forest, as mapped in the Australia State of the Forest Report (Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee, 2018). All the selected planning units meeting the >10% forest cover threshold were included for our Marxan analysis. This resulted in 118,219 planning units being selected and 233,321 units being excluded. Excluded planning units consisted of non-forest areas, including those mostly cleared for agriculture or urban development, as well as rangelands throughout central and northern Australia. Of the planning units containing >10% of their respective areas mapped as forest cover, 37,166 were within the protected area network under IUCN categories I-VI. In our Marxan analysis, we assigned these planning units as "conserved." The remaining 81,053 planning units outside of the protected area network featuring >10% of mapped forest cover were assigned as "available" in our Marxan analysis. We chose the size and number of planning units on the basis that optimal solutions can be difficult to find when using very large numbers of planning units (Serra-Sogas et al., 2020).

In setting our conservation targets for the 688 forest-dependent and woodland-dependent species in Marxan, we followed methods similar to those used by Lindenmayer and Taylor (2023), Watson et al. (2011), and Rodrigues et al. (2004). In those studies, the authors set conservation area targets for each species based on threatened status and extent. For this study, we used the extent of species' distribution to determine conservation area targets set by Rodrigues et al. (2004), which emphasized conservation targets scaled according to a species' range size. For species with very small ranges (<1000 km^2), the representation target was set at 100% of their range to ensure full protection. For species with very large ranges (>250,000 km^2), the target was set at 10% of their range, reflecting the approximate regional coverage of protected areas. Intermediate-range species had their targets interpolated between these two extremes. A constant representation target would disproportionately favor widespread species. For instance, protecting 10% of a wide-ranging species' habitat covers a significant area, while the same percentage might be insufficient for a narrow-range species. This scaled conservation target-based approach ensured that narrow-ranged species were fully or largely protected, while wide-ranging species were assigned proportionately smaller conservation targets. The thresholds and scaling provide a methodical approach to equitably prioritize conservation efforts across species with varying ecological needs.

We modeled a logistic function to determine conservation targets based on species occurrence range (Figure 2). Species with occurrence ranges <1000 km^2 were assigned a 100% conservation target, while those >250,000 km^2 were assigned a 10% target. The fitted logistic model was

$$P = \frac{L}{1 + e^{-k(\log_{10}(a_i) - x_0)}} + b,$$

where P is the conservation target as a percentage, a_i is the total range area (in km^2) of species i, L is a constant −90, x_o is a constant 4.20, k is a constant 5.0, and b is a constant 100. All parameters were statistically significant ($p < .001$), indicating the fitted logistic regression curve matched the target setting curve presented by Rodrigues et al. (2004). This approach ensured full protection for species with narrow distributions, while applying proportionately lower targets to wide ranging species.

We used the CLUZ Marxan plugin in QGIS to generate Marxan results (Smith, 2019). Our Marxan settings were for 100 million iterations over 1000 runs. The Marxan outputs included an irreplaceability value for each planning unit, based on its Selection Frequency. Selection Frequency is the number of times a planning unit is selected during the analysis to achieve the specified conservation targets (Serra-Sogas et al., 2020). Planning units that were selected between 901 and 1000 times (>90% of the time) were considered highly irreplaceable, as they were repeatedly required to meet conservation targets for forest- and woodland-dependent species of national environmental significance.

2.6 | Extent of logging by state owned enterprises certified under Responsible Wood

Our analysis of logging in state-owned forests certified under the Responsible Wood scheme was constrained by limited and inconsistent data. Publicly available information from state governments and forest management agencies restricted our study of historic logging to Victoria and New South Wales, focusing on operations by VicForests and Forestry Corporation NSW, respectively

Conservation Science and Practice
A Journal of the Society for Conservation Biology
Open Access
WILEY

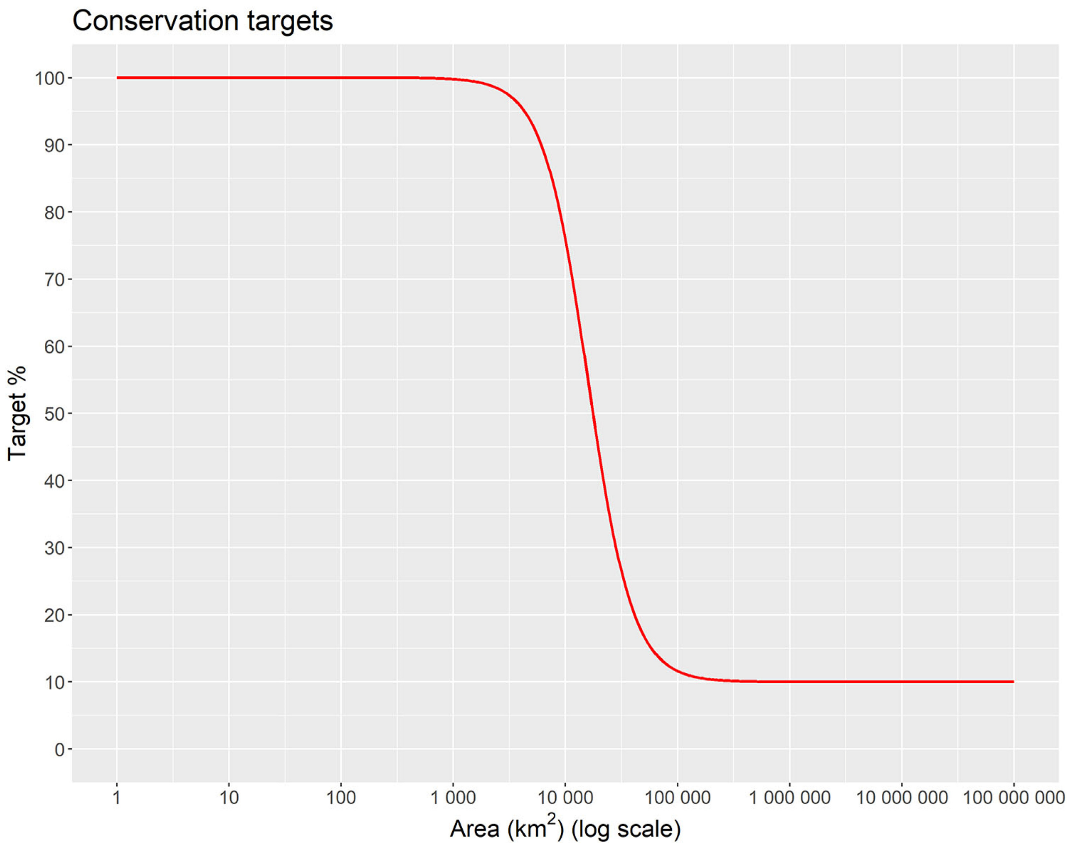

FIGURE 2 Logistic model used to establish conservation targets in Marxan based on Rodrigues et al. (2004).

(Figure 3). No other state or territory has published or released data on historic logging operations, either on government-managed land or on private land. Our analysis of logging accounted for the year of logging and the method of logging used by the respective government-owned logging agencies. Both VicForests and Forestry Corporation NSW were awarded certification under Responsible Wood when it was the Australian Forest Certification scheme in 2007.

2.6.1 | Victoria

The most reliable dataset available was for the state of Victoria, as provided by the DataVic website, which contains a comprehensive coverage of logging events across the state that have been verified with aerial photography (DJPR, 2023). This dataset also identifies the agency responsible for each logging event, which enabled us to determine those areas logged by the state-owned enterprise for the state, which was VicForests (Figure 3). It also listed the method of logging used. We extracted logging history polygons from 2007 to 2023, which was the period from when VicForests was first awarded certification under the then Australian Forestry Standard (SAI Global, 2007) and later renamed the Responsible Wood Standard (Standards Australia, 2021), to the cessation of native forest logging in state forests across Victoria by the end of 2023. We analyzed the total area logged by year and the silvicultural method used (DJPR, 2023). The silvicultural methods listed were clear-fell logging, thinning from above, thinning from below, single tree selection and group selection. Of these methods, clear-fell logging is the most intensive form of logging, which involves the removal of all trees and vegetation from an assigned area or coupe (Flint & Fagg, 2007). We also defined variable retention logging and salvage logging as clearfell logging in our analysis. Overlapping logged area polygons were removed to avoid area duplication.

2.6.2 | New South Wales

Publicly available data detailing logging history are provided by the Forestry Corporation of New South Wales (Figure 3) (Forestry Corporation of NSW, 2024). We extracted logging history polygons from 2007 to 2023,

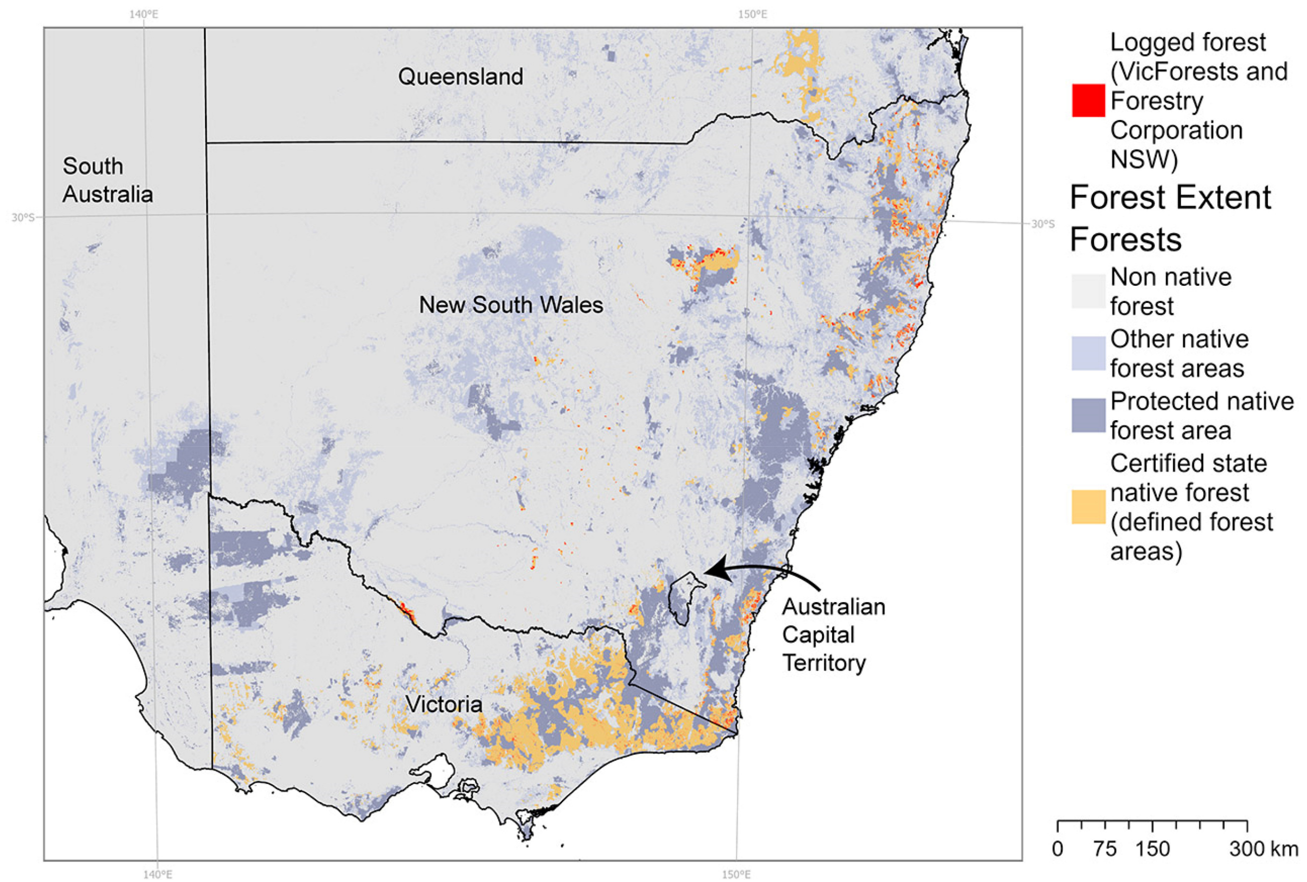

FIGURE 3 Areas of logging in native forest across New South Wales and Victoria by the state-owned forestry agencies VicForests and Forestry Corporation NSW.

commencing the year Forestry Corporation of NSW was first awarded certification under the then Australian Forestry Standard (NCS International, 2013). However, the Forestry Corporation of New South Wales advises that these data should be considered as indicative due to the highly variable nature of its historical mapping and because the data are incomplete. It further advises that logging history data are assigned to whole compartments, but those do not reflect the actual extent of logging, although it is a reasonable representation at the landscape scale (1:100,000 or greater) (Forestry Corporation of NSW, 2024). We confined our logged area calculations to areas defined by Forestry Corporation of NSW as General Management Zones and Special Prescription Zones, in which logging operations are permitted (State Forests NSW, 1999). We analyzed the total polygon area logged by year and the silvicultural method used. The silvicultural methods include Australian Group Selection, clear-fell logging, thinning and single tree selection at light, medium and heavy intensities (Forestry Corporation of NSW, 2024). Overalpping logged area polygons were removed to avoid area duplication.

3 | RESULTS

3.1 | Optimal areas for protecting forest-dependent species

Our Marxan analysis indicated that the existing protected area network does not meet the conservation targets for 90% of forest and woodland species of national environmental significance and that gaps remain within the current reserve system. We calculate that the median conservation target met for the existing protected area network across all 688 species is 28.4%, with 201 species having less than 10% of their respective ranges within the protected area network (Figure 4). To meet the conservation targets we set for forest- and wood-dependent species of national environmental significance, we calculate an additional 42.7 million ha of planning units (~19%) featuring forest and woodlands would need to be added to the existing protected area system.

With gaps identified in the existing protected area network, our Marxan analysis identified 16,409 planning units outside the formal protected area network, featuring a native forest area of 16.3 million ha, achieving the

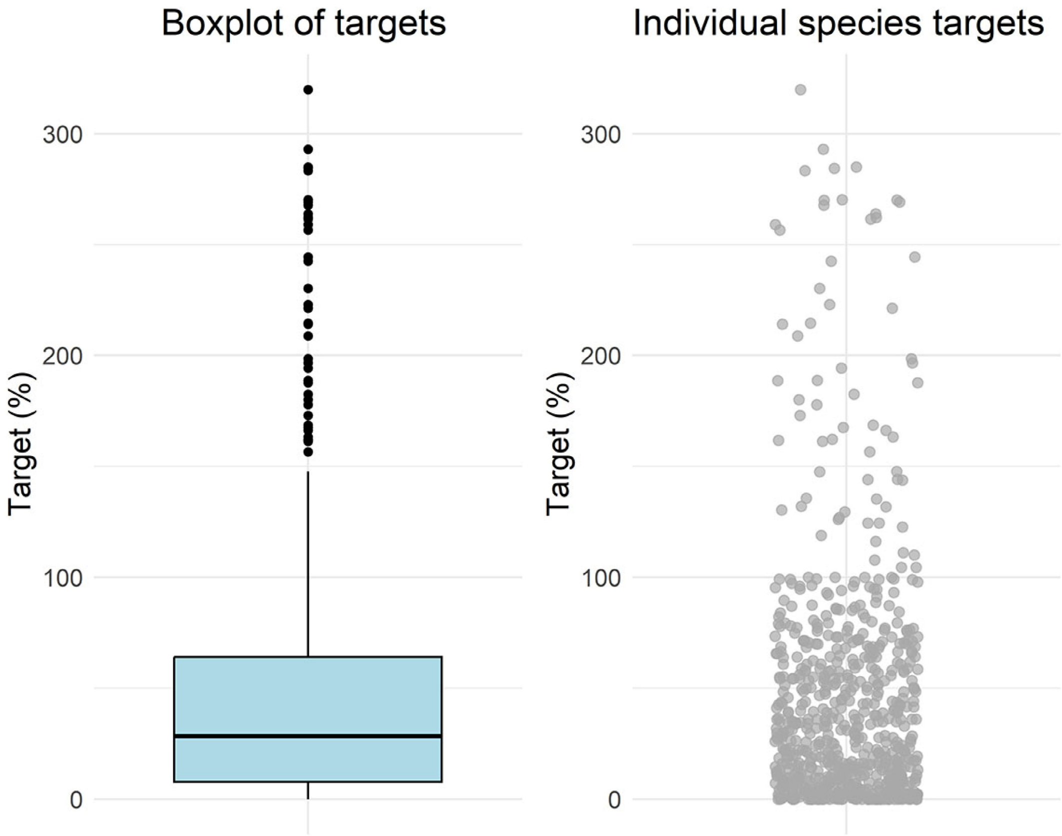

FIGURE 4 Species-level conservation targets under the current protected area system shown as a boxplot (left) and jittered dot plot (right). Each dot represents an individual species. The boxplot shows the median and interquartile range; whiskers extend to values within 1.5 × IQR. Outliers are shown as black dots. Species with values >100% indicate their respective conservation targets are exceeded by the existing protected area system.

highest scoring category (Selection Frequency 901–1000; >90%). In this analysis, planning units achieving the highest scoring category are irreplaceable in a conservation context and would qualify as optimal areas for the protection of forest and/or woodland species of national environmental significance (Figure 5).

3.2 | Extent of logging across state-owned forest management enterprises in Victoria and New South Wales

3.2.1 | Victoria

Across the VicForests certified defined native forest area, we estimated that an annual average of 36% of the native forest logged annually between 2007 (when VicForests was first awarded certification under the Responsible Wood standard) and 2023 was located within irreplaceable planning units achieving the highest scoring category (Selection Frequency 901–1000; >90%) (Figure 6). When including areas with a Selection Frequency score of 501–1000 (>50%), this proportion increased to 75%. Approximately 80% of logged areas were subject to clear-fell logging, with 16,271 ha of clear-fell logged coupes located within planning units achieving a Selection Frequency of 901–1000 (>90%) (Figure 6).

3.2.2 | New South Wales

Across the certified defined native forest area for Forestry Corporation NSW, we calculated that an annual average of 53% of the areas mapped as logged since certification was first awarded were within planning units achieving the highest scoring category (Selection Frequency 901–1000; >90%) (Figure 6). When including areas with a Selection Frequency of 501–1000 (>50%), this proportion increased to nearly 60%. Approximately 52% of logged areas were mapped as using single tree selection of medium intensity, with 103,633 ha using this silvicultural method located within planning units achieving a Selection Frequency of 901–1000 (>90%). We also calculated that around 24,520 ha, mapped by Forestry Corporation

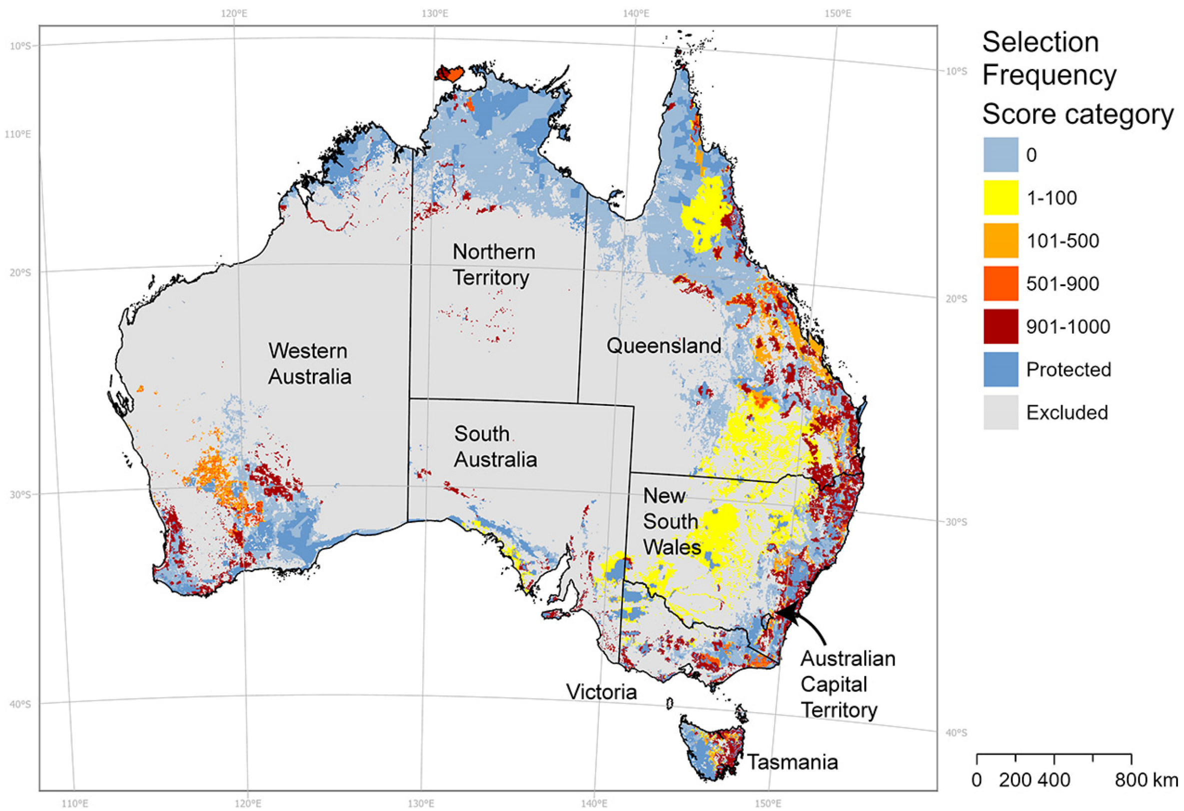

FIGURE 5 Selection Frequency (SF) for Planning Units estimated by Marxan analysis for the 688 forest- and woodland-dependent species of national environmental significance (SNES) outside of the protected area network.

NSW as logged with heavy intensity single tree selection, were located in planning units in the >90% score category.

4 | DISCUSSION

Conserving forest biodiversity is a critical part of halting biodiversity loss globally. This is because forests support a large proportion of the world's species (United Nations, 2023), including species at risk of extinction (Intergovernmental Science-policy Platform on Biodiversity and Ecosystem Services (IPBES), 2019). However, effective forest biodiversity conservation is dependent on tackling the threats leading to loss, including those of a direct human origin such as logging (Lindenmayer & Franklin, 2002; Watson et al., 2018). Here, based on analyses across Australia, we examined the performance of the existing protected area network. Our study assessed the relationships between the location of optimal areas with significant biodiversity values that could be considered for inclusion in the protected area network. Additionally, we investigated whether these optimal areas for protecting species of national environmental significance had been logged in Victoria and New South Wales and certified under the Responsible Wood scheme. Our study is indicative of a high level of spatial conflict between our identified optimal areas for protecting forest- and woodland-dependent species of national environmental significance and industrial wood production awarded certification in the two Australian States that we examined—Victoria and New South Wales.

What is the extent of forests and woodlands containing optimal areas for forest-and woodland-dependent species outside of protected areas across Australia?

Our study revealed that the existing protected area network does not meet the conservation target we derived from Rodrigues et al. (2004). Indeed, the forest- and woodland-dependent species we examined have around a median of only 28% of their target areas for conservation met. We estimate an additional 42.7 million ha of planning units covering forest and woodlands would need to be added to the existing reserve system to meet the conservation targets used in our study.

Have forest and woodland areas that had been covered by forest certification schemes and that supported optimal areas for forest- and woodland-dependent species been subject to intensive logging operations?

The second question which motivated this study concerns the effectiveness of certification schemes to

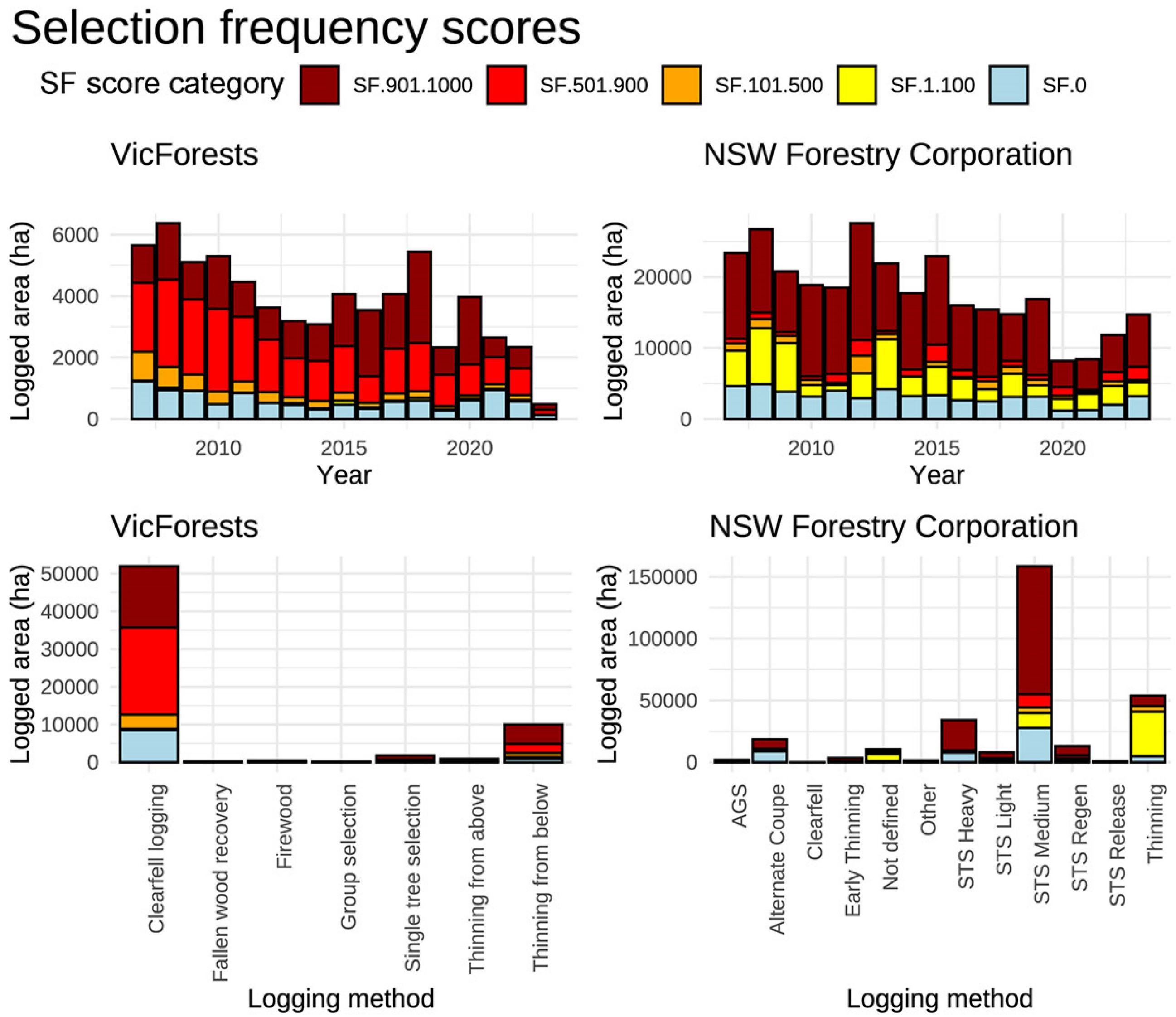

FIGURE 6 Area logged per year and method of logging across defined certified forest areas for VicForests and Forestry Corporation NSW with their respective Selection Frequency (SF) scores.

meet one of their core objectives: that is, the protection of significant biodiversity values. We found that a large proportion of logging has occurred within optimal areas for the protection of forest- and woodland-dependent species of national environmental significance that could be otherwise considered for inclusion into the protected area network (Figure 6 and Table 1). Approximately one-half of areas logged across New South Wales were in forests characterized by planning units that were in the most irreplaceable (Selection Frequency 901–1000; >90%) and hence optimal areas for protecting forest- and woodland-dependent species. For Victoria, around one-third of logged areas occurred in the most irreplaceable areas (Selection frequency 901–1000; >90%) for protecting forest- and woodland-dependent species.

Our analysis examined only one aspect of "significant biodiverse values" (i.e., known or likely occurrences of threatened species and their known or potential habitat). Our scope was limited by the availability of nationally consistent, spatially explicit data that could be applied uniformly across multiple jurisdictions. If other features such as threatened ecological communities, old-growth forest, and areas with regionally or nationally significant concentrations of native species were to be included, we suspect these overlaps to be higher.

Our analyses indicate that logging operations are compromising Australia's intention to meet its conservation goals. Similar results have been documented in earlier studies that have highlighted the substantial biodiversity values of wood production forest (Lindenmayer & Taylor, 2023; Taylor &

TABLE 1 Summary data on the annual average percentage of coupes logged within Victoria (VicForests) and New South Wales (Forestry Corporation of NSW) in planning units with highest selection frequency scores for forest-dependent and/or woodland-dependent species of national environmental significance.

State	Selection Frequency 901–1000 (>90%) scoring planning units	Selection Frequency 501–1000 (>50%) scoring planning units
VicForests (Victoria)	36.1%	75.7%
Forestry Corporation of NSW (mapped logged history—polygons)	53.4%	59.3%

Note: Column 2 shows the annual average % of logged areas in Planning Units with the highest scoring category (Selection Frequency 901–1000; >90%). Column 3 shows values for the annual average % of logged areas in Planning Units scoring with a Selection Frequency of 501–1000 (>50%).

Lindenmayer, 2019). In particular, agencies such as VicForests have noted in various court cases that the financial viability of their operations would have been undermined if they were precluded from logging areas that supported threatened species (Lindenmayer & Burnett, 2021). The underlying ecological reasons why there are such spatiotemporal conflicts between logging and conservation merit further study. However, it is possible that areas most suitable for logging are often also those that are most productive for tree growth (e.g., Larson et al., 2008), but such productive locations also support the best habitat for many species (Braithwaite et al., 1984).

The Responsible Wood standard explicitly includes the known or likely occurrences of threatened species and their known and potential habitat as a category of significant biodiversity values (Responsible Wood, 2021). The standard requires (under Clause 11.3.2 of AS/NZS 4708:2021) that certified forest managers "*develop and implement effective strategies to maintain or enhance significant biodiversity values*" (Standards Australia, 2021). In this study, we focused on a single category for significant biodiversity values—known or likely occurrences of threatened species and their known and potential habitat—using the Species of National Environmental Significance dataset as a nationally consistent proxy for identifying these values. How certified forest managers assess such values may vary between certified forest management enterprises, based on a combination of scientific knowledge, stakeholder input, legal obligations, and internal assessments. However, audit summaries released to the public by certified forest management agencies may not disclose how they assessed for significant biodiversity values.

Using a conservation planning approach that employed the program Marxan, our analysis indicated that a substantial proportion of areas logged in Victoria and New South Wales were located within the most irreplaceable planning units (Selection Frequency 901–1000; >90%), which would likely qualify as having significant biodiversity values of forest- and woodland-dependent species of national environmental significance under the Responsible Wood forest management standard. While our analysis indicates that forests and woodlands with *significant biodiversity values*, at least in terms of known or likely occurrences and known or potential habitat, were logged often using the most intensive forms of silviculture such as clear-fell logging (DJPR, 2023), we acknowledge that differences in the way forest management enterprises identify significant biodiversity values may partially explain this outcome. In other words, forest and woodland areas identified as achieving the highest scoring category (Selection Frequency 901–1000; >90%) in this analysis may not have been identified as having significant biodiversity values by the certified forest management agencies. Regardless, the overlap between logged areas and the most irreplaceable planning units identified in our analysis raises concerns whether certification schemes like Responsible Wood are sufficiently robust to prevent the degradation of significant biodiversity values caused by logging. This is of particular concern given that intensive forms of logging employed in many locations has been shown to have prolonged negative impacts on an array of species, including species of conservation concern (e.g., Blair et al., 2016; Lindenmayer et al., 2020; Ough & Murphy, 2004).

Studies elsewhere around the world have indicated that forest certification schemes can have positive outcomes for enhanced biodiversity conservation (e.g., Zwerts et al., 2024). However, our analyses have revealed the urgent need for substantial reform of the Responsible Wood certification scheme in Australia. This is because our study indicates that certification under the scheme may lack the ability to protect areas of *significant biodiversity values* from industrial logging. We believe that the certification scheme should be reformed in ways that ensure it is driven by proper pre-logging biodiversity assessments, with logging excluded from places where it erodes conservation values. As an example, the mapping we have produced highlights key areas of forest that should be exempt from logging and, ideally, subject to tenure change to be incorporated into fully protected areas such as National Parks.

The management of forests in Australia is underpinned by the concept that the protected area system for biodiversity conservation should be comprehensive, adequate, and representative—the CAR principles (Commonwealth of Australia, 1992). Several studies have shown that the current forest reserve system in Australia does not meet the objectives of the CAR principles (e.g., Taylor et al., 2017; Taylor & Lindenmayer, 2019; Watson et al., 2011). Our study further reaffirms the findings of these studies, with optimal areas for protecting forest- and woodland-dependent species remaining outside of the protected area network and at risk of degradation. This deficiency in protected area adequacy is of particular concern given we have demonstrated the overlap of intensive forms of logging such as clear-felling and the occurrence of threatened forest- and woodland-dependent biodiversity in off-reserve areas. Given such problems, we recommend that governments in Victoria and New South Wales revisit their respective reserve networks and significantly expand them to better protect significant biodiversity value areas and the suite of threatened species within them. This recommendation would also apply to other states where logging occurs. Without a move to expand systems of protected areas in south-eastern Australia, there is a major risk that Australian Government pledges to halt extinction in this country (Australian Government, 2022) will be a failed commitment.

4.1 | Improvements in data and accessibility

A limitation in this study was the availability and quality of data. Data on species of national environmental significance are indicative only and provide a starting point for further investigation (DCCEEW, 2024). Some individual Australian state governments provide more detailed habitat importance models, such as Victoria (DELWP, 2017), but these are state-specific and other Australian states have not generated or published data consistent with those states that have published species distribution models. The benefit of using the species of national environmental significance data is that is it nationally consistent. However, improvements in the quality of species distribution data are urgently required to improve the transparency and accountability around any threatening process for species of national environmental significance.

We also contend that logging history on public land by government owned logging agencies need to be made publicly available across all states and territories. The state of Victoria has made detailed spatial records of logging history publicly available (DEECA, 2023); Forestry Corporation NSW has also made spatial records of its logging history available, however, these data have several limitations, including incomplete or unreliable historical data (especially pre-2010), varying spatial resolutions, and potential discrepancies in harvesting data. The data published by Forestry Corporation NSW are considered indicative and best suited for landscape-scale analysis (1:100 k or greater), with older data potentially unsuitable for analyses at finer scales (Forestry Corporation of NSW, 2024). Other states where logging on public land has occurred include Tasmania, Western Australia, and Queensland. These states do not publish any data on historical logging operations by their respective state-owned logging agencies. Given that all these state-owned logging agencies are certified under the Responsible Wood scheme and that they operate on public land, public access to these spatial data is in the public interest.

Data on planned logging operations are variable across jurisdictions. The availability of planned logging data is critical for determining whether future logging will adversely impact areas of significant biodiversity values, especially for certified forest management enterprises. In Victoria, VicForests previously provided spatial data for planned logging operations under its Timber Release Plan prior to its closure (VicForests, 2023a), which enabled proactive spatial analysis. By contrast, Forestry Corporation NSW does not provide publicly accessible spatial data detailing planned logging. It provides details on its planned operations through a non-downloadable web interface without GIS compatibility (Forestry Corporation NSW, 2025). These inconsistencies in data availability can limit the efficacy of consistent data analysis for planned logging operations across multiple jurisdictions.

5 | CONCLUDING COMMENTS

Our analysis indicates that the existing protected area network across Australia does not adequately represent the range of species of national environmental significance. In addition, areas that would be optimal for inclusion into the protected area network have likely been subject to logging in Victoria and New South Wales. Moreover, these logged areas were assigned certification under the Responsible Wood certification scheme, even though many were identified as being irreplaceable according to our Marxan analysis. Our findings highlight the need for urgent reform in Australia's certification schemes and the importance of a significant expansion in protected areas.

ACKNOWLEDGMENTS

We thank Luke Gordon and Karen Brock for editorial assistance in manuscript preparation. We acknowledge the First Nations Peoples on whose land the analyses reported in this paper were conducted. Open access publishing facilitated by Australian National University, as part of the Wiley - Australian National University agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest. Chris Taylor previously served on the Board of Directors of FSC Australia and New Zealand from 2012 to 2014, and again briefly in 2020 to fill a casual vacancy.

DATA AVAILABILITY STATEMENT

The data will be made available on the data repository Dryad.

ORCID

Kita Ashman https://orcid.org/0000-0002-6943-6318
David B. Lindenmayer https://orcid.org/0000-0002-4766-4088

REFERENCES

ABARES. (2023). *Australia's state of the forests report: Synthesis 2023*. Australian Government.

AFPA NSW. (2021). *Multi-use forests and sustainable native forestry important for biodiversity*. Australian Forest Products Association (NSW).

Australian Government. (2022). *Threatened species action plan. Towards zero extinctions*. Austtralian Government.

Ball, I. R., Possingham, H. P., & Watts, M. E. (2009). Marxan and relatives: Software for spatial conservation prioritization. In A. Moilanen, K. A. Wilson, & H. P. Possingham (Eds.), *Spatial conservation prioritisation: Quantitative methods and computational tools* (pp. 185–210). Oxford University Press.

Blair, D., McBurney, L., Banks, S., & Lindenmayer, D. B. (2016). Disturbance gradient shows logging affects plant functional groups more than fire. *Ecological Applications*, *26*, 2280–2301.

Bradshaw, C. J. (2012). Little left to lose: Deforestation and forest degradation in Australia since European colonization. *Journal of Plant Ecology*, *5*, 109–120.

Braithwaite, L. W., Turner, J., & Key, J. (1984). Studies on the arboreal marsupial fauna of eucalypt forests being harvested for woodpulp and Eden, New South Wales. III. Relationships between the faunal densities, eucalypt occurrence and foliage nutrients and soil parent materials. *Australian Wildlife Research*, *11*, 41–48.

Clode, D. (2006). *As if for a thousand years*. Victorian Environment Assessment Council.

Coetzee, B. W. T., Gaston, K. J., & Chown, S. L. (2014). Local scale comparisons of biodiversity as a test for global protected area ecological performance: A meta-analysis. *PLoS One*, *9*, e105824.

Commonwealth of Australia. (1992). *National forest policy statement*. Australian Government Publishing Service.

Commonwealth of Australia. (1999). *Australian guidelines for establishing the national reserve system*. Environment Australia.

Dargavel, J. (1995). *Fashioning Australia's forests*. Oxford University Press.

DCCEEW. (2023). *Collaborative Australian protected areas database (CAPAD): Protected area data*. DCCEEW.

DCCEEW. (2024). *EPBC act list of threatened Fauna*. DCCEEW.

DEECA. (2023). *Harvested logging coupes (one layer per logging season)*. DEECA.

DELWP. (2017). *Native vegetation regulation (2017) habitat importance models (HIM) for VROTs species*. Department of Environment, Land, Water & Planning.

Department of Agriculture Fisheries and Forestry. (2023a). *Annual report 2022–2023*. Australian Government.

Department of Agriculture Fisheries and Forestry. (2023b). *Australia state of the Forest report—1.1a.i forest area by forest type (2023)*. Department of Agriculture Fisheries and Forestry.

Department of Agriculture Fisheries and Forestry. (2023c). *Australia state of the forest report—1.1a.ii forest area by tenure*. Department of Agriculture Fisheries and Forestry.

Department of Agriculture Fisheries and Forestry. (2024). *Indicator 2.1a: Native forest available for wood production, area harvested, and growing stock of merchantable and non merchantable tree species (2024)*. Department of Agriculture Fisheries and Forestry.

Dinerstein, E., Joshi, A. R., Hahn, N. R., Lee, A. T., Vynne, C., Burkart, K., Asner, G. P., Beckham, C., Ceballos, G., Cuthbert, R., Dirzo, R., Fankem, O., Hertel, S. W., Li, B. V., Mellin, H., Pharand-Deschênes, F., Olson, D., Pandav, B., Peres, C. A., … Zolli, A. (2024). Conservation imperatives: Securing the last unprotected terrestrial sites harboring irreplaceable biodiversity. *Frontiers in Science*, *2*, 1349350.

DJPR. (2023). *Harvested logging coupes (one layer per logging season)*. Department of Jobs, Precincts and Regions Department of Jobs, Precincts and Regions.

Dudley, N. (2008). *Guidelines for applying protected area management categories*. International Union for Conservation of Nature.

ESRI. (2022). *ArcGIS Pro (version 3.0)*. ESRI.

FAO. (2020). *Global forest resources assessment 2020: main report*. Food and Agriculture Organization.

Flint, A., & Fagg, P. (2007). *Mountain ash in Victoria's state forests*. Department of Sustainability and Environment.

Forestry Corporation NSW. (2025). *Coastal IFOA Native Forest operations*. Forestry Corporation NSW.

Forestry Corporation of NSW. (2024). *HFD harvest history*. Forestry Corporation of NSW.

Freeman, M. (2023). *Open letter: Great Koala National Park NSW*. Forestry Australia.

FSC. (2021). *Chain of custody certification FSC-STD-40-004 V3-1*. Forest Stewardship Council.

FSC. (2024). *Facts and figures*. FSC.

FSC Australia. (2019). *High conservation value (HCVS) evaluation framework: For use in the context of implementing controlled wood standards—V1.1*. FSC Australia.

Gibson, L., Lee, M. L., Koh, L. P., Brook, B. W., Gardner, T. A., Barlow, J., Peres, C. A., Bradshaw, C. J. A., Laurance, W. F., Lovejoy, T. E., & Sodhi, N. S. (2011). Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature*, *478*, 378–381.

Griffiths, T. (2002). How many trees make a forest? Cultural debates about vegetation change in Australia. *Australian Journal of Botany*, *50*, 375–389.

Intergovernmental Science-policy Platform on Biodiversity and Ecosystem Services (IPBES). (2019). *IPBES global assessment summary for policymakers*. IPBES.

Kirkpatrick, J. B. (1983). An iterative method for establishing priorities for the selection of nature reserves: An example from Tasmania. *Biological Conservation*, *25*, 127–134.

Larson, A. J., Lutz, J. A., Gersonde, R. F., Franklin, J. F., & Hietpas, F. F. (2008). Potential site productivity influences the rate of forest structural development. *Ecological Applications*, *18*, 899–910.

LCC. (1994). *Melbourne area district 2 review: Final recommendations*. Land Conservation Council, Melbourne. Retrieved from http://www.veac.vic.gov.au/documents/360-Full-Doc.pdf

Legge, S. M., Rumpff, L., Garnett, S. T., & Woinarski, J. C. (2023). Loss of terrestrial biodiversity in Australia: Magnitude, causation, and response. *Science*, *381*, 622–631.

Lindenmayer, D., Blanchard, W., Blair, D., McBurney, L., Taylor, C., Scheele, B. C., Westgate, M. J., Robinson, N., & Foster, C. (2020). The response of arboreal marsupials to long-term changes in forest disturbance. *Animal Conservation*, *24*, 246–258. https://doi.org/10.1111/acv.12634

Lindenmayer, D. B., & Burgman, M. A. (2005). *Practical conservation biology*. CSIRO Publishing.

Lindenmayer, D. B., & Burnett, P. (2021). Biodiversity in court: Will the regional Forest agreements (RFAs) make the EPBC Act irrelevant? *Pacific Conservation Biology*, *28*, 393–397.

Lindenmayer, D. B., & Franklin, J. F. (2002). *Conserving forest biodiversity: A comprehensive multiscaled approach*. Island Press.

Lindenmayer, D. B., & Taylor, C. (2023). How well do immediate protection areas conserve biodiversity in Victorian forests? *Pacific Conservation Biology*, *29*, 471–489.

Lunney, D., Hutchings, P., & Dickman, C. (2018). Can we reverse the machinery which has ground down so much of this country? The value of protected areas for fauna conservation: Editors' prologue. *Australian Zoologist*, *39*, 161–169.

Margules, C. R., & Pressey, R. L. (2000). Systematic conservation planning. *Nature*, *405*, 243–253.

Matias, G., Cagnacci, F., & Rosalino, L. M. (2024). FSC forest certification effects on biodiversity: A global review and meta-analysis. *Science of the Total Environment*, *908*, 168296.

Maxwell, S., Fuller, R. A., Brooks, T., & Watson, J. (2016). Biodiversity: The ravages of guns, nets and bulldozers. *Nature*, *536*, 143–145.

Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee. (2018). *Australia's state of the forests report 2018*. ABARES.

Moulds, F. R. (1991). *The dynamic forest: A history of forestry and forest industries in Victoria*. Lynedoch Publications.

Munks, S. A., Chuter, A. E., & Koch, A. J. (2020). "Off-reserve" management in practice: Contributing to conservation of biodiversity over 30 years of Tasmania's forest practices system. *Forest Ecology and Management*, *465*, 117941.

NCE and Indufor. (2022). *Assessing the net benefits of multiple use native forest management in Queensland*. South & Central Queensland Regional Forestry Hub.

NCS International. (2013). *Forestry corporation of NSW—Australian forestry standard AS 4708 certificate*. NCS International.

Newsom, D., Bahir, V., & Cashmore, B. (2006). Does certification matter? An analysis of operation-level changes required during the Smartwood certification process in the United States. *Forest Policy and Economics*, *9*, 197–208.

Nussbaum, R., & Simula, M. (2005). *The forest certification handbook* (2nd ed.). Earthscan.

Ough, K., & Murphy, A. (2004). Decline in tree-fern abundance after clearfell harvesting. *Forest Ecology and Management*, *199*, 153–163.

PEFC. (2022). *PEFC and FSC double certification 2016–2022*. PEFC.

PEFC. (2023). *PEFC annual review*. PEFC.

Responsible Wood. (2021). *Sustainable forest management—Requirements*. Responsible Wood.

Responsible Wood. (2024a). *Annual report of activities 2023–2024*. Responsible Wood.

Responsible Wood. (2024b). *Find certified*. Responsible Wood.

Rodrigues, A. S. L., Andelman, S. J., Bakarr, M. I., Boitani, L., Brooks, T. M., Cowling, R. M., Fishpool, L. D. C., da Fonseca, G. A. B., Gaston, K. J., Hoffmann, M., Long, J. S., Marquet, P. A., Pilgrim, J. D., Pressey, R. L., Schipper, J., Sechrest, W., Stuart, S. N., Underhill, L. G., Waller, R. W., … Yan, X. (2004). Effectiveness of the global protected area network in representing species diversity. *Nature*, *428*, 640–643.

SAI Global. (2007). *Certificate of registration—VicForests*. SAI Global.

Serra-Sogas, N., Kockel, A., Game, E. T., Possingham, H. P., & McGowan, J. (2020). *Marxan user manual: For Marxan version 2.43 and above*. The Nature Conservancy and Pacific Marine Analysis and Research Association (PacMARA).

Smith, R. (2019). The CLUZ plugin for QGIS: Designing conservation area systems and other ecological networks. *Research Ideas and Outcomes*, *5*, e33510.

Standards Australia. (2021). *AS/NZS 4708:2021 Australian/New Zealand standard sustainable forest management—Requirements*. Responsible Wood.

State Forests NSW. (1999). *Managing our forests sustainably: Forest management zoning in NSW state forests*. State Forests of NSW.

Steffen, W., Richardson, K., Rockström, J., Cornell, S., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., & Sorlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*, 736–745.

Taylor, C., Cadenhead, N., Lindenmayer, D. B., & Wintle, B. A. (2017). Improving the design of a conservation reserve for a critically endangered species. *PLoS One*, *12*, e0169629.

Taylor, C., & Lindenmayer, D. B. (2019). The adequacy of Victoria's protected areas for conserving its forest-dependent fauna. *Austral Ecology*, *441*, 1076–1090.

United Nations. (2023). *What is goal 15: Life on land?* UN Department of Global Communications.

VicForests. (2023a). *Timber release plan*. VicForests. Retrieved from https://www.vicforests.com.au/vicforest-forest-management/ops-planning/where-vicforests-operates/timber-release-plan#:~:text=The%20Timber%20Release%20Plan%20(TRP,state%20forests%2C%20including%20timber%20harvesting

Visconti, P., Butchart, S., Brooks, T. M., Langhammer, P. F., Marnewick, D., Vergara, S., Yanosky, A., & Watson, J. E. (2019). Protected area targets post-2020. *Science*, *364*, 239–241.
Watson, J. E., Evans, M. C., Carwardine, J., Fuller, R. A., Joseph, L. N., Segan, D. B., Taylor, M. F., Fensham, R. J., & Possingham, H. P. (2011). The capacity of Australia's protected-area system to represent threatened species. *Conservation Biology*, *25*, 324–332.
Watson, J. E., Evans, T., Venter, O., Williams, B., Tulloch, A., Stewart, C., Thompson, I., Ray, J. C., Murray, K., Salazar, A., McAlpine, C., Potapov, P., Walston, J., Robinson, J. G., Painter, M., Wilkie, D., Filardi, C., Laurance, W. F., Houghton, R. A., … Lindenmayer, D. B. (2018). The exceptional value of intact forest ecosystems. *Nature Ecology and Evolution*, *2*, 599–610.
World Economic Forum. (2023). *50% of the global economy is under threat from biodiversity loss*. World Economic Forum.
WWF Australia. (2023). *Trees scorecard 2023*. WWF Australia.
Zwerts, J. A., Sterck, E. H., Verweij, P. A., Maisels, F., van der Waarde, J., Geelen, E. A., Tchoumba, G. B., Zabaze, H. F. D., & van Kuijk, M. (2024). FSC-certified forest management benefits large mammals compared to non-FSC. *Nature*, *628*, 563–568.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Taylor, C., Ashman, K., Ward, M., Possingham, H., & Lindenmayer, D. B. (2025). Have significant biodiversity values been protected from industrial logging across Australia? *Conservation Science and Practice*, *7*(8), e70089. https://doi.org/10.1111/csp2.70089