Government of **Western Australia**
Conservation and Parks Commission

End-of-term review of performance of the **Forest Management Plan 2014–2023**

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Cover photos

Main King Jarrah Tree, Wellington National Park. *Photo – DBCA*
Inset left Western quoll. *Photo – Kim Branch/DBCA*
Inset centre Wansborough Walk and Bolganup Trail, Porongurup National Park. *Photo – Tourism WA*
Inset right Red-tailed black cockatoos. *Photo – DBCA*

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Foreword

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The *End-of-term review of performance of the Forest Management Plan 2014-2023* (end-of-term performance review) is an important process to highlight both current achievements and areas of future focus. Considerations for future forest management are particularly important in light of the Western Australian Government's forest policy announcement in September 2021, which will be implemented through the next *Forest Management Plan 2024-2033* (FMP 2024-2033).

The Department of Biodiversity, Conservation and Attractions (DBCA) and the Forest Products Commission (FPC) have continued to implement the *Forest Management Plan 2014-2023* (FMP 2014-2023) to a high standard, consistent with the plan's goals and management activities and the suite of guidance documents that underpin them.

In response to the 17 recommendations made by the Conservation and Parks Commission (CPC) when it undertook the *Mid-term review of performance of the Forest Management Plan 2014-2023* (mid-term performance review) in 2018-19, DBCA has provided additional information on a range of matters, including threatened flora and fauna, management of weeds and pest animals, fire management and carbon inventory.

The continuing impact of the drying, warming climate of Western Australia's south-west remains evident, with declines in vegetation cover seen particularly in the northern jarrah forest and significant impacts on water runoff, stream flows and groundwater levels that are most pronounced in the northern parts of the FMP area. Responding to the ongoing impacts of climate change on south-west native forests will be a key element of FMP 2024-2033.

Changes are also being observed in more southern, higher rainfall regions. Trials have been undertaken to increase the forest's resilience to a drying climate through thinning to reduce water competition, with research indicating the impact of drought and heatwaves is lower in thinned catchments.

Studies by DBCA scientists are improving our understanding of how these impacts are manifesting. Indeed, research and monitoring continue to strengthen DBCA's ability to map and report on forest condition, predict future impacts and plan management activities in response, and provide valuable information to the CPC to inform it in the performance of its role.

On-ground management action remains a key component in responding to the threat posed by feral animals, weeds and plant diseases to the unique biodiversity of the south-west forests. DBCA's Western Shield program is critical to supporting survival in the wild of a range of threatened mammals, birds and reptiles. DBCA has also continued to implement the prescribed burning program across the south-west to manage the threat of bushfire to the forest landscape.

It is pleasing to note that visitor satisfaction has remained consistently high, rising from approximately 90 per cent in 2013-14 and 2017-18 to 94 per cent in 2020-21. Visitation to south-west forests has increased by 28 per cent, reaching 12.4 million visitors during 2020-21. Several new and upgraded recreation sites and campgrounds have been developed to support this increase in visitation.

With the State Government's announcement in September 2021 to end large-scale commercial timber harvesting in south-west native forests from 2024, the CPC is now focussed on developing the next FMP 2024-2033. The information reported through this end-of-term performance review will be important in informing the next plan, supporting the focus on forest health.

Finalisation of the South West Native Title Settlement (SWNTS) in 2021 provides for greater involvement of Noongar people in managing south-west forests into the future. DBCA will continue to work closely with traditional owners over the coming years.

I would like to acknowledge CPC members Jo Lanagan and Tahn Donovan who have reviewed and commented on draft versions of this report.

On behalf of the CPC I would also like to acknowledge the expertise and commitment DBCA and FPC staff have continued to bring to bear in successfully implementing the FMP 2014-2023.

Professor Chris Doepel, PSM
Chair

Executive Summary

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FMP 2014-2023 provides the policy framework and overall goals for managing Western Australia's south-west native forests. These goals include to conserve biological diversity, protect and maintain Noongar and other cultural heritage values, and to sustain the productive capacity of native forest ecosystems.

FMP 2014-2023 applies to public lands in the Forest Management Plan FMP area which are vested in the Conservation and Parks Commission (CPC) and managed by the Department of Biodiversity, Conservation and Attractions (the department) under provisions of the *Conservation and Land Management Act 1984* (CALM Act).

The *End-of-term review of performance of the Forest Management Plan 2014-2023* (end-of-term performance review) has been prepared by the department on behalf of the CPC consistent with the requirements of management activities 130-132. The purpose of the end-of-term performance review is to report on the extent to which management of land to which the plan applies, has been undertaken in accordance with the plan.

FMP 2014-2023 included a comprehensive set of key performance indicators (KPIs), including performance targets, which have formed the basis for both the *Mid-term review of performance of the Forest Management Plan 2014-2023* (mid-term performance review), released in 2019, and the end-of-term performance review.

The end-of-term performance review has built on the findings of the mid-term performance review to enable an assessment of KPIs across the period 2014-2021. The CPC made 17 recommendations in the mid-term performance review for the department to provide further information, report at specified intervals, and to prioritise actions to allow improved reporting in the future. The department provided further information during 2019-2021 to the CPC addressing these recommendations and this information is summarised in the individual KPI reports.

These performance reviews provide the mechanism for reporting by the CPC to the Minister for Environment, other interested parties and the broader Western Australian community, on the extent to which ecologically sustainable forest management (ESFM) outcomes for south-west forests have been met.

A report card summarising the mid-term and end-of-term performance reviews against the targets for the KPIs of FMP 2014-2023 is presented in Table 1. For the end-of-term performance review, 82 per cent of performance targets were assessed as being achieved or largely met, an increase from 80 per cent in the mid-term performance review. Performance targets where there has been no progress remains consistent with the mid-term performance review at four per cent.

Legend

Reporting metric	Rating and symbol	
Achievement / progress	Performance target not achieved / no progress	
	Performance target not achieved but performance measure or success criteria are met in some cases	
	Performance target not achieved but performance measure or success criteria are often met	
	Performance target achieved	
Direction of progress (compared to previous period)	Improved	↗
	Steady	—
	Decreased	↘
Confidence in rating (C)	Low	L
	Medium	M
	High	H

Table 1. Summary of performance against key performance indicator targets.

Report card

KPI	Performance target	Year	Achievement	C
1.1	No decline in the condition of identified healthy ecosystems listed across the whole of forest	2017	↘	H
		2021	↘	H
1.2	An increase in formal protection of regionally significant vegetation as identified in the applicable regional nature conservation plans	2017	—	H
		2021	—	H
2	The target condition of TECs and PECs identified as priorities for management in the relevant regional nature conservation plans	2017	—	M
		2021	—	H
3	The target condition of Ramsar and nationally listed wetlands as identified in the relevant regional nature conservation plans	2017	↘	H
		2021	—	H
4	(Threatened flora) As defined in the relevant regional nature conservation plans	2017	—	L
		2021	↘	L
5	(Threatened fauna) As defined in the relevant regional nature conservation plans	2017	↘	M
		2021	↘	M
6a	Conformance to the theoretical distribution of time since fire for whole of forest	2017	—	H
		2021	↗	H
6b	Conformance to the theoretical distribution of time since fire for major LMUs	2017	—	H
		2021	—	H
7.1	90 per cent of prescribed burns that meet their stated objective	2017	—	M
		2022	—	H
7.2	Completion of the relevant regional fire management plans by mid-term	2017	↗	H
		2021	Not applicable	
8.1	(Distribution or density of priority weeds) as defined in the relevant regional nature conservation plans	2017	↗	M
		2021	↘	M
8.2	(Distribution or density of priority pests) as defined in the relevant regional nature conservation plans	2017	—	L
		2021	↗	M
8.3	(Distribution or density of priority diseases) as defined in the relevant regional nature conservation plans	2017	↘	M
		2021	↘	M
8.4a	No planned operations undertaken without an approved Hygiene Management Plan – timber harvesting	2017	↘	H
		2021	↗	H
8.4b	No planned operations undertaken without an approved Hygiene Management Plan – other disturbance activities	2017	↗	M
		2021	—	M
8.4c	Less than three per cent of uninfested protectable area infested as a result of management activities – timber harvesting	2017	↘	H
		2021	↘	H
8.4d	Less than three per cent of uninfested protectable area infested as a result of management activities – other disturbance activities	2017	—	L
		2021	—	L
9	Soil damage not to exceed prescribed maximum levels for 95 per cent of harvested cells surveyed (full text in FMP)	2017	—	H
		2021	—	H
10.1	No gauging stations with annual flow weighted mean salinity that is not fresh as a result of management activities	2017	—	H
		2021	—	H
10.2	No sites with a decline in streamflow as a result of management activities	2017	—	H
		2021	—	H
10.3	No decline or rise in groundwater level that could lead to stream salinity not remaining fresh as a result of management activities.	2017	—	H
		2021	—	H

KPI	Performance target	Year	Achievement	C
11	Effectiveness of silviculture for water production	2017	Not applicable	H
		2021	Not applicable	H
12	Trend and knowledge report compiled at end of-term and used to inform reporting on achievement of KPI targets	2017	—	H
		2021	—	H
13	Adaptive responses to be reported at end of-term	2017	—	H
		2021	—	H
14	Twenty plots established and reported by end of-term	2017	—	H
		2021	—	H
15	No permanent loss of net area of forested land due to unauthorised activities	2017	—	H
		2021	—	H
16.1	Cumulative removals of first and second grade jarrah and karri sawlogs shall not exceed allowable cut	2017	—	H
		2021	—	H
16.2	No more than the allowable cut of other bole volume of jarrah and karri and total bole volume of marri logs over the 10-year plan period.	2017	Not yet due	
		2021	—	H
16.3	No more than the allowable cut of wandoo, blackbutt and sheoak sawlogs to be removed over the 10-year plan period	2017	Not yet due	
		2021	—	H
17.1a	Annual area of each silvicultural outcome for each forest type harvested and/or silviculturally treated (in karri)	2017	—	H
		2021	—	H
17.1b	Annual area of each silvicultural outcome for each forest type harvested and/or silviculturally treated (in jarrah)	2017	—	H
		2021	—	H
17.2	Silvicultural practices assessed by monitoring surveys against the requirements as prescribed (in jarrah)	2017	—	H
		2021	—	H
18.1a	For karri and planted jarrah achieve more than 75 per cent of areas treated to be completed within 18 months	2017	—	H
		2021	—	H
18.1b	For karri and planted jarrah achieve 100 per cent of areas treated to be completed within 30 months	2017	—	H
		2021	—	H
18.1c	For jarrah which has not been planted achieve 90 per cent of areas treated to be completed within 30 months except in accepted circumstances	2017	—	H
		2021	—	H
18.2	No more than five per cent of the area regenerated requiring remedial action – jarrah operations	2017	—	H
		2021	—	H
18.3	No more than five per cent of the area replanted requiring remedial action – clearfelled plantations	2017	—	H
		2021	—	H
19	Target as defined in the State agreements and contracts1	2017	—	H
		2021	—	H
20.1	Establishment of at least six joint management arrangements under the CALM Act by 2023	2017	Not yet due	
		2021	Not yet due	
20.2	Local area arrangements and protocols for Aboriginal customary activities established and implemented within each district by 2023	2017	Not yet due	
		2021	—	H
20.3	Appropriate and representative Noongar groups are consulted and invited to provide input into all management plans	2017	—	H
		2021	—	H

KPI	Performance target	Year	Achievement	C
21.1a	All high value sawlog resource processed or value added locally	2017	—	H
		2021	—	H
21.1b	An increase in low value resource taken on by local markets[1]	2017	—	H
		2021	—	H
21.2	Increased local processing capacity[1]	2017	—	M
		2021	↗	H
21.3	Employment and social benefits maintained or increased[1]	2017	—	L
		2021	—	M
22.1	Level of visitation to be maintained or increased	2017	↗	H
		2021	↗	H
22.2	No target, trends to be reported (recreation and tourism facilities)	2017	No target	
		2021	No target	
22.3	Visitor satisfaction to meet or exceed Departmental benchmark	2017	—	H
		2021	—	H
23	Access via strategic road network to be maintained	2017	↘	H
		2021	↘	H
24.1	Guidance documents to be prepared and/or reviewed as required during the period of the plan	2017	—	H
		2021	—	H
24.2a	Research projects address identified high priority knowledge gaps	2017	—	H
		2021	—	H
24.2b	Peer reviewed articles are produced by research projects	2017	—	H
		2021	—	H
24.2c	Knowledge gained is communicated to policy makers and operational managers	2017	—	H
		2021	—	H
24.3a	Public attendance for key education, awareness and extension programs to be maintained	2017	—	H
		2021	—	H
24.3b	Volunteer contribution (number of volunteers and volunteers hours) to be maintained	2017	—	H
		2021	—	H

[1] As assessed by the FPC

The mid-term performance review analysed the best available information for the 24 KPIs in FMP 2014-2023. A summary of the analysis was presented in a report for each KPI and this approach has been repeated for the end-of-term performance review.

Key themes that were evident in the implementation of FMP 2014-2023, outlined in the assessment of the KPIs and performance targets include climate change and its impact, the forest products industry, monitoring and reporting, and resources for implementation. Other than the forest products industry, these remain pertinent and additional commentary is provided on these themes below. Additional focus has also been given to the other threats and pressures managed in the FMP area.

CLIMATE CHANGE AND ITS IMPACT

The impact of climate change, particularly higher temperatures and declining rainfall, on south-west forest ecosystems, was a key theme of the mid-term performance review. This trend has continued with vegetation decline evident across the FMP area, particularly in the Jarrah North East and Wandoo Forest and Woodland forest ecosystem types (KPI 1). In the Southern forest ecosystems, areas of both declining and increasing vegetation condition are evident, however there has been no net loss of vegetation cover. Declining streamflow and groundwater levels were evident in the forest ecosystem areas (KPI 10). Ecological thinning trials are underway to investigate if this management activity can reduce moisture stress in the short and longer term by reducing the number of smaller trees in an area of forest.

For the majority of threatened and priority-listed ecological communities, vegetation cover has been found to have stabilised. For those communities where declining vegetation cover remained evident, declining rainfall was a notable factor (KPI 2). Adaptation to climate change pressures on wetlands has continued, with the department working collaboratively with other agencies to undertake management actions and prioritise work to mitigate pressures on wetland condition (KPI 3).

Research is a major factor in improving the ability to map and report on the condition of forests, enabling the department to predict and plan management activities around the changing climate. Research has improved the understanding of the impacts of climate change on forest ecosystems (KPI 12) and supported development of adaptation strategies (KPI 13).

OTHER THREATS AND PRESSURES

Management actions including fire management, feral and pest animal control, *Phytophthora* dieback control, fencing, signage, and translocations were undertaken to protect threatened and priority native fauna and flora populations and conserve forest ecosystems across the FMP area. The department has continued to implement the prescribed burning program to manage the bushfire threat across the forest landscape. The range of fuel ages across forest ecosystems generally conforms to the target distribution (KPI 6). Changes in fire management have been implemented, such as larger mosaic burns to provide further variation in the landscape following fire. Where practicable, local scale operations consider appropriate measures to minimise loss of legacy habitat elements, such as tree hollows and fallen hollow logs (KPI 7).

Foxes and feral cats continue to be the most significant pest animals in the FMP area due to their impact on native fauna through predation. Western Shield and local programs deliver landscape control of these pest species through aerial and ground baiting over approximately 86 per cent of the FMP area (KPI 8).

Within available resources, the department has responded to infestations of weeds in areas of higher conservation value and implemented subsequent monitoring to allow reporting on the extent and changes in weed populations and density within the FMP area (KPI 8).

MONITORING AND REPORTING OF KPIS

As reported in the mid-term performance review, evaluation of the extent to which the management of land has been undertaken in accordance with the plan has continued to be hindered by inconsistent processes for collecting, storing and managing data and information across the department.

The need to ensure that KPI targets are both measurable and meaningful in indicating where the department can effectively manage pressures has been reiterated. It is notable that impacts that may be attributable to development and urbanisation, are not readily managed by the department. This is particularly evident for biodiversity values on the Swan Coastal Plain portion of the FMP area.

RESOURCES FOR IMPLEMENTATION

Similar to the situation reported in the mid-term performance review, resources were largely unchanged for the end-of-term performance review, providing an ongoing constraint to the implementation of FMP management activities. Due to resourcing during this FMP period, there were not the opportunities to increase the department's focus on other disturbance activities that may have impacted south-west forests.

Where resourcing and funding was suitable and consistent, the opportunities to deliver operations and build on the successes from the mid-term performance review were continued. In addition, where the department has provided training and increased compliance, for example in disease management and to minimise soil damage, improvements in performance have been made (KPIs 8 and 9).

CONSIDERATIONS FOR FOREST MANAGEMENT PLAN 2024-2033

The preparation of *Forest Management Plan 2024-2033* (FMP 2024-2033) is underway. The policy settings for FMP 2024-2033 will see major changes with large-scale commercial timber harvesting to cease and active forest management for forest health to be the priority.

Based on the assessment of the KPIs and performance targets for the end-of term performance review, a number of considerations have been identified to inform the preparation of FMP 2024-2033, and these are provided as part of each KPI report. Overarching considerations to inform the management activities and KPIs for the next FMP include:

1. maintaining the science capability within the department;
2. the development of consistent monitoring protocols;
3. implementation of an integrated monitoring program; and
4. development of meaningful and achievable KPIs.

The scope and approach to forest management actions that improve forest health, including thinning for ecological purposes, will be canvassed through the development of FMP 2024-2033.

CPC commentary

The end-of term performance review for FMP 2014-2023 has considered the status of 50 measures to indicate the achievement or otherwise of performance targets for 24 KPIs. The end-of-term performance review provides the final report for FMP 2014-2023. The CPC notes that 82 per cent of the performance targets have been achieved or largely met, with 14 per cent only met in some cases, and four per cent not achieved or not progressed.

This achievement is generally consistent with the mid-term performance review. The CPC acknowledges the work undertaken by the management agencies, and notes the challenges faced in delivering the results with resource constraints and competing priorities.

As outlined in both the end-of-term and mid-term performance reviews, climate change is impacting the northern jarrah and wandoo forest ecosystems. The research undertaken by the department, and in collaboration with other organisations, is providing an important contribution to our understanding of the changes within forest ecosystems and guiding adaptive management practices. FMP 2024-2033 will incorporate a greater focus on managing for forest health and climate resilience.

The importance of the native forests in providing recreational opportunities for Western Australians is evident through the high rates of visitation during the COVID-19 pandemic. The CPC acknowledges the significant contribution by volunteers to forest management activities.

The broad range of considerations for FMP 2024-2033, outlined in the end-of-term performance review, are endorsed by the CPC. Of note is the need for an integrated monitoring program that will ensure management of the south-west forests is able to respond and adapt to the threats and pressures into the future.

The CPC notes that given large-scale commercial timber harvesting will cease from 2024, the emphasis of FMP 2024-2033 will be very different to FMP 2014-2023, with a greater focus on forest health, and a new set of KPIs will be developed.

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FMP 2014-2023 provides the key policy framework for protecting and managing south-west forests in accordance with the principals of ESFM, as described in the CALM Act. FMP 2014-2023 applies to all lands vested in the CPC within the State's south-west forests.

FMP 2014-2023 has a focus on State forest and timber reserves because it is primarily on these land categories that disturbance activities are carried out. These lands fall within the department's Swan, South West and Warren administrative regions (Figure 1). FMP 2014-2023 is a 10 year plan that was developed in consultation with key stakeholders and the community.

FMP 2014-2023 identifies goals and outlines 24 KPIs with 50 targets to assess the effectiveness of the plan in meeting its goals and measure progress towards implementation of the proposals. The KPIs and performance targets are focussed on key aspects of the plan.

A total of 134 management activities were proposed to achieve each goal outlined in FMP 2014-2023 and to protect the identified values and/or address identified threats. Management activities 130-132 of FMP 2014-2023 required the CPC, through the department, to prepare a mid-term performance review (completed February 2019) and this end-of-term performance review.

The mid-term performance review assessed the management of land to which the plan applies, including the extent to which KPI targets were being achieved. The end-of-term performance review follows a similar process and provides an updated status for the KPIs, performance targets and management activities. In addition, this end of-term performance review considers the extent to which the KPIs have been able to capture the effectiveness, or outcomes achieved, from the specified management activities.

This allows for the identification of factors to be considered to inform the preparation of FMP 2024-2033.

1.1 Approach

A protocol was developed for each KPI (as per management activity 121 of FMP 2014-2023) to specify how the measurement of each KPI was to be undertaken. Protocols for KPIs 1, 2, 3, 4, 5, and 8 had not been finalised in the term of FMP 2014-2023 as they were dependent on the preparation of regional conservation plans that were not finalised within the term of the plan. However, the draft protocols were used to report on performance.

Reports and data have been submitted from multiple divisions across the department, the Department of Water and Environmental Regulation (DWER) and the Forest Products Commission (FPC) to inform the preparation of individual reports for each KPI against the established protocols, or alternative methods agreed to assess performance. The level of achievement attributed to each KPI was determined by the department and provided to the CPC to enable the end-of-term performance review over the period 2014-2021.

The approach for reporting reflects the style of the mid-term performance review including a 'traffic light' grading approach. The assessment of KPIs and management activities has primarily been an assessment of progress. At the completion of the end-of-term performance review not all management actions attributed to a KPI will reflect an "Achieved/Completed" status, as these activities are either ongoing or have not been completed within the timeframe. The extent to which a KPI and performance target can be assessed may be limited by, for example, the availability of data for reporting, capacity to obtain measurable data, or the cost of implementing a desired monitoring program.

Figure 1. Area covered by FMP 2014-2023.

2 Key performance indicator reports

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The main findings, highlights and achievements during the reporting period include:

- Climate change is considered a significant factor in declining forest vegetation cover and health, particularly in the Jarrah North East and Wandoo Forest and Woodland ecosystems.
- Investigations have improved the ability to map and report on the condition of forests and enhanced the ability to predict how the forest will respond to future climate change.
- Preparation of regional conservation plans is underway with completion expected in 2022. The plans will identify prioritised conservation actions to be delivered by regional staff, with support from other sections of the department, to address threats to biodiversity values.
- The department is working collaboratively with other government agencies and organisations to undertake management actions and prioritise work to assist in managing threats and adapt to pressures from the changing climate.
- Ongoing management of introduced predators through Western Shield and local baiting programs are contributing to the continued persistence of many populations of threatened fauna in the FMP area.
- Development of the department's Disturbance Approval System (DAS), a streamlined online system for planning, assessing, and approving (where appropriate) all disturbance activities on CALM Act lands has, enabled a more rapid and efficient approach to managing operations carried out on department-managed lands.
- Training for proponents and staff undertaking disturbance activities has reduced soil disturbance and improved compliance with dieback disease management plans.
- Evaluation of thinning trials within native forest has identified that groundwater and streamflow respond to this management technique. Ecological thinning trials in Munro and Hamilton forest blocks will continue to build on the department's understanding of forest hydrological cycles.
- A more strategic approach has been taken to the use of prescribed fire by incorporating timber harvesting, mining and karri regrowth burns into integrated prescribed burn plans.
- Maintaining and improving on visitation and visitor satisfaction during this FMP period (2014-2021) occurred despite fluctuations due to the COVID-19 pandemic.

2.1 KPI 1 Whole of forest condition

KPI	Performance target	Year	Achievement				C
1.1	No decline in the condition of identified healthy ecosystems listed across the whole of forest.	2017		↘			H
		2021			↘		H
1.2	An increase in the formal protection of regionally significant vegetation as identified within the applicable regional nature conservation plans.	2017	—				H
		2021	—				H

2.1.1 Condition of Ecosystems

BACKGROUND

The analysis of whole-of-forest condition for the mid-term performance review identified that changes (decline) in the condition of forest ecosystems were most pronounced in the north (Jarrah North East and Jarrah North West forest ecosystems[2]) and east (Western Wandoo Forest and Woodland forest ecosystems) of the FMP area. The least affected ecosystems were in areas of higher or more stable rainfall.

The CPC recommended that the department further investigate the cause of decline in vegetation density and provide information on the factors contributing to reduced density in affected forest ecosystems.

The department undertook to investigate the cause of decline in forest cover. The investigation used climatic data, an explanatory model and field survey to attribute possible causes to the reported decline.

STATUS

The study of vegetation cover decline over the forest estate has shown that certain ecosystem types, together with location in the landscape are associated with a declining vegetation cover, as a result of climatic drivers (rainfall and vapour pressure deficit). Understanding of the extent and factors contributing to vegetation cover decline has improved, enhancing the ability to predict how the forest will respond to future climate change. The investigations have also strengthened the ability to map and report on the condition of forests that will be managed under the FMP 2024-2033.

The research indicated that site location and aspect have a direct correlation to decline of the northern jarrah forest. Data collected show that location can influence the vegetation's vulnerability to climate change. Areas burnt during the 2008-2017 period showed a declining vegetation cover trend, while those areas that were burnt prior to this period had an increasing vegetation cover trend.

Changes in vegetation cover, using imagery from Landsat can be modelled to a high degree of accuracy and can be used as an indicator of vegetation condition. Trends in vegetation density reported in the mid-term performance review (2008-2017) can be compared to the trends for the current 10-year period (2012-2021) (Figure 2). Activities or events known to result in short to medium-term changes in vegetation cover including prescribed burns, bushfire and silvicultural treatment that occurred between 2016 and 2021 were considered in the analysis. Areas impacted by mining were not included.

The difference between the trends from 2008-2017 and 2012-2021 (Figure 3) demonstrate that vegetation decline remains most pronounced in the jarrah and wandoo forest ecosystems. Karri and tingle were the least affected forest ecosystems.

[2] Forest Ecosystems map available at:

https://www.awe.gov.au/sites/default/files/SiteCollectionImages/rfa/regions/wa/regional-assesment/volume-2-maps/rfa_eco.gif

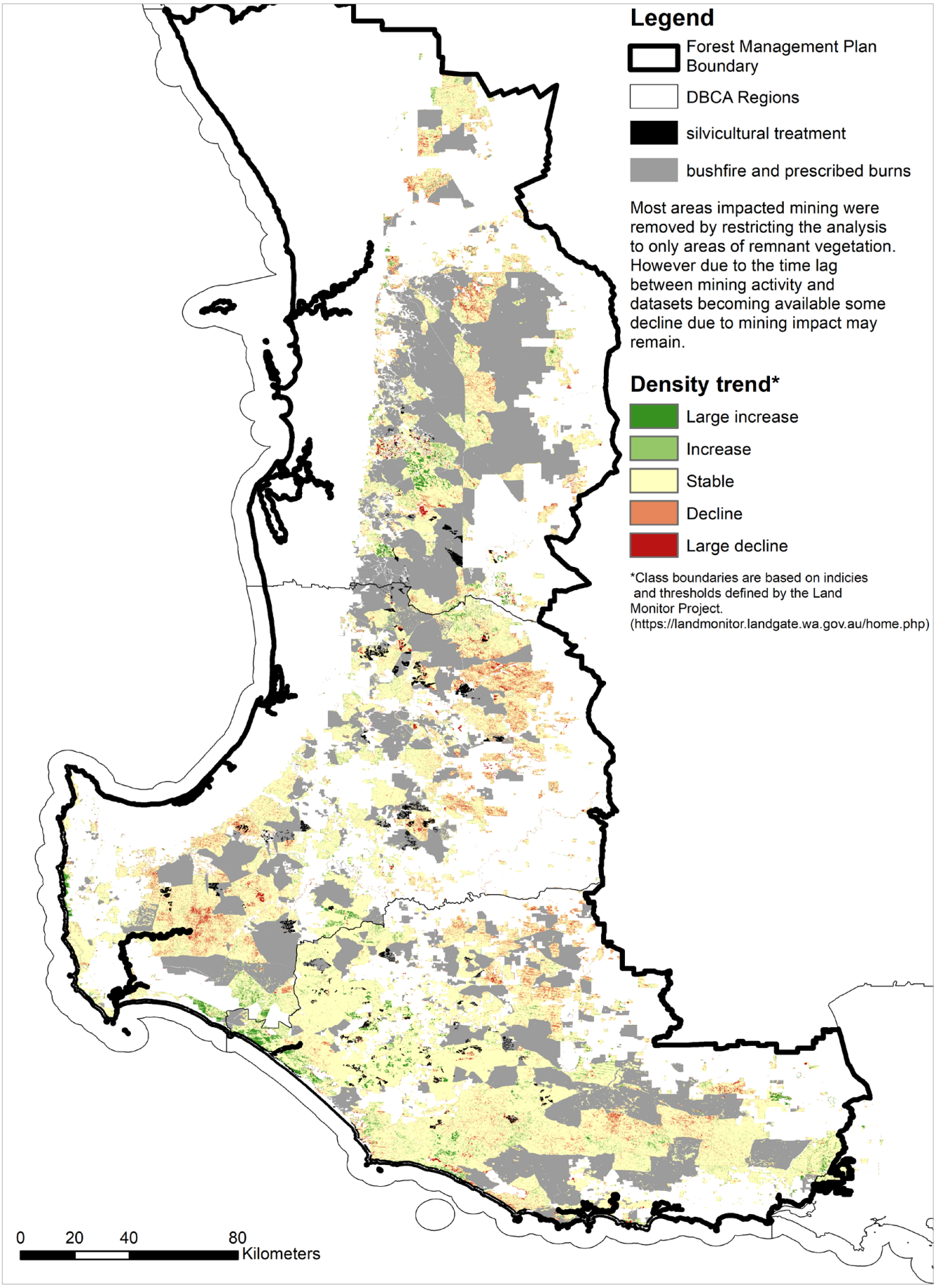


Figure 2. Vegetation density trends within the forest management plan area between 2008-2017 and 2012-2021, and areas where changes were observed as a result of bushfire, prescribed burns and silviculture treatments from 2016-2021.

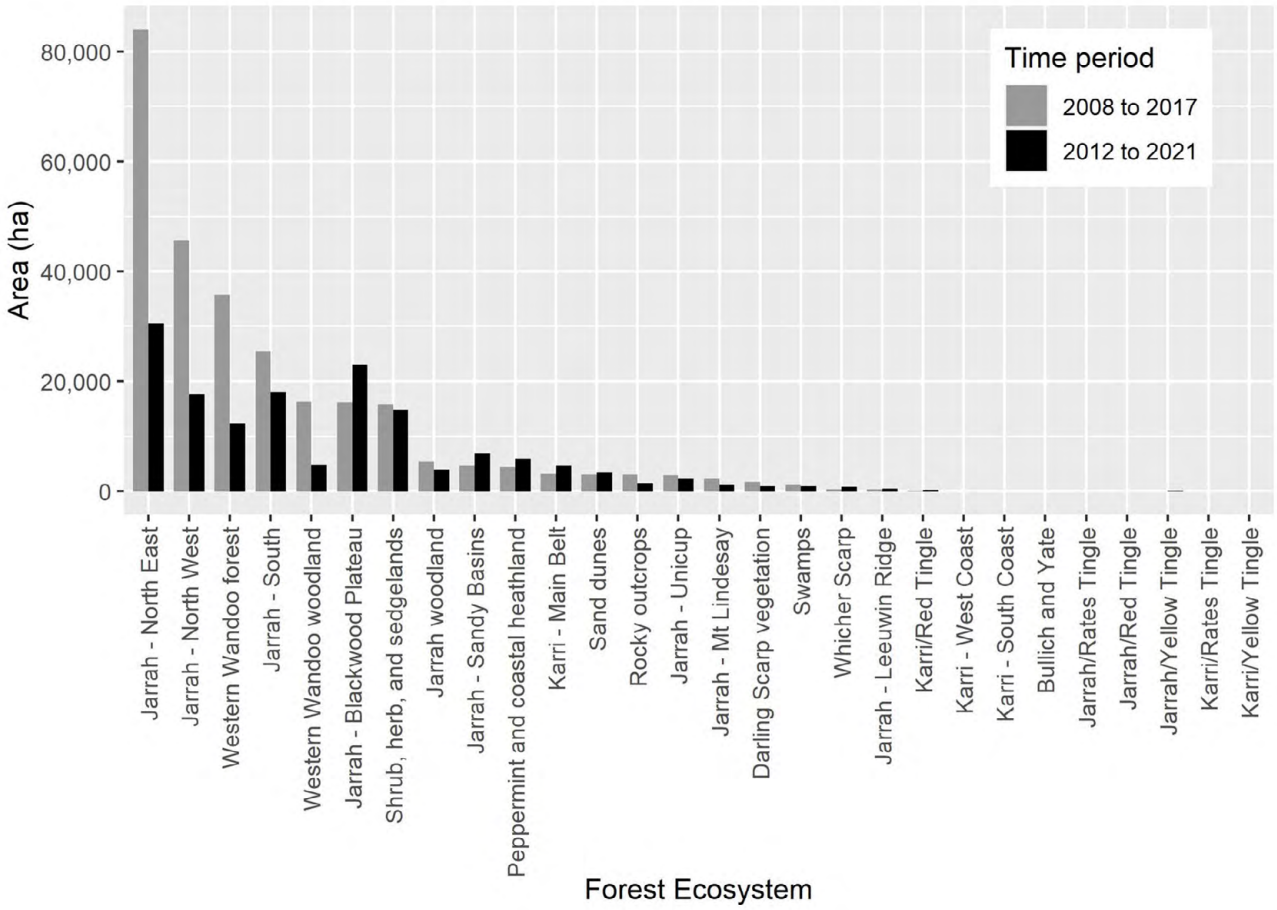


Figure 3. Area of forest with observed declining trend in vegetation cover during 2008-2017 and 2012-2021.

RATING

- Analysis of climatic data suggests that rainfall decline is not evenly distributed across the south-west. Rainfall for the period 1951-1980 was compared to rainfall from1981-2018 for the Northern Jarrah Forest Interim Biogeographic Regionalisation for Australia (IBRA) subregion (Figure 4) as this was the area showing the greatest decline in vegetation condition. Rainfall in this area has declined by more than nine per cent along the coast from Bunbury to Perth and east across the Wheatbelt.
- Large areas of declining rainfall and higher temperatures contributed to the changes observed in vegetation cover (see KPI 12), with the longer-term reduction in rainfall that has been occurring since the 1970s resulting in reduced streamflow, lower groundwater levels and altered forest hydrology (see KPI 10).
- Field surveys undertaken by the department in 2020-21, that measured site and stand characteristics and die-off indicated that sites where the decline was most pronounced often had a north or east facing aspect, whereas stable sites were mainly west or south facing. Decline sites had a higher occurrence of banksia woodlands and jarrah than stable sites, that were wandoo dominated.
- Climate change is considered a significant factor in changing forest vegetation cover and health, particularly in the Jarrah North East and Wandoo Forest and Woodland ecosystems, and it is unlikely that management actions or authorised activities have significantly contributed to this. The level of understanding of factors contributing to decline in the jarrah forest has increased and will allow the department to predict and plan management activities around the changing climate.

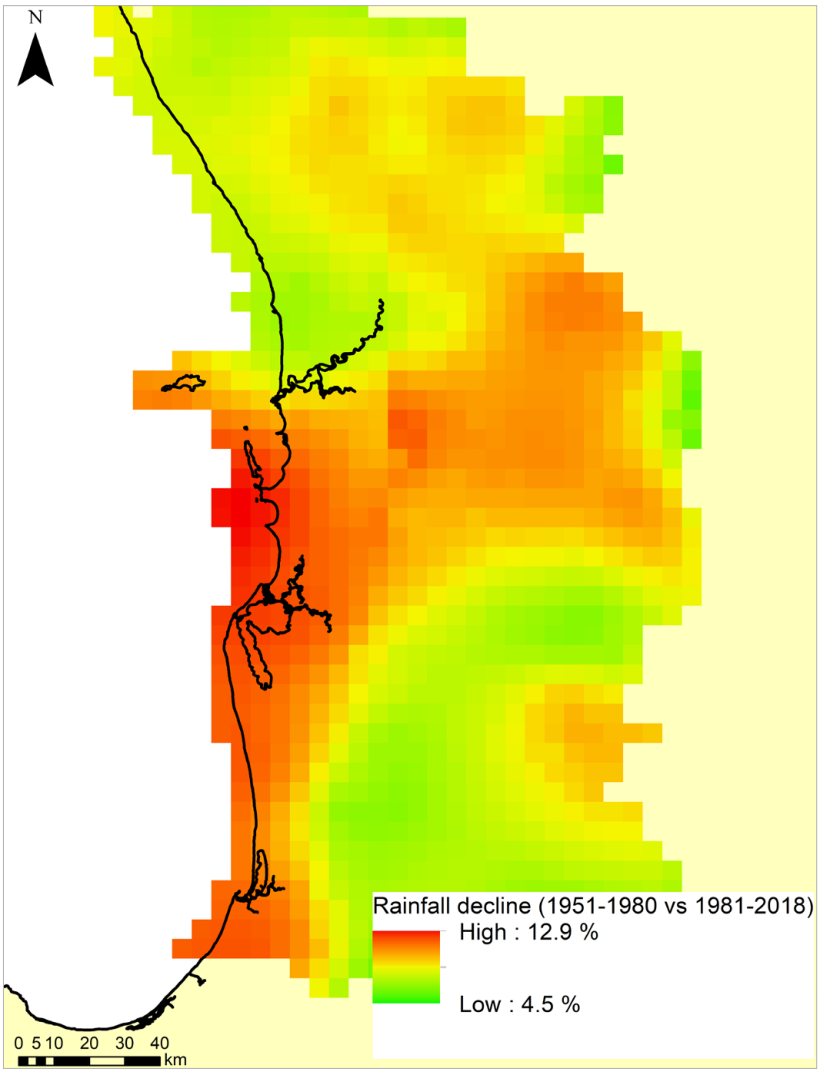


Figure 4. Rainfall change across the Swan Region, using the mean annual rainfall from 1951-2080 compared with 1981-2018.

MANAGEMENT RESPONSE FOR THIS FMP

- To assess vegetation condition for FMP 2014-2023, the mean vegetation cover value derived from imagery for each forest ecosystem type from the current reporting period (2014-2021) was compared to the previous period (2004-2013) (Figure 5). The mean vegetation cover method is preferred over the linear trends approach used above and in the mid-term performance review as seasonal influences and short-term variance are reduced. The difference in the mean vegetation cover of each ecosystem can be highlighted by subtracting the mean cover for 2004-2013 from that for 2014-2021 (Figure 6).
- The dominant feature of this cover change map is the large area of decline in the north-east of the FMP area. This coincides with the location of the Western Wandoo Woodland and the Jarrah North East forest ecosystems. Smaller pockets of 'decline' and 'increase' are also visible, many of these areas may relate to transient impacts and vegetation recovery associated with bushfire, prescribed burns and silviculture treatments.
- Consistent with findings of the mid-term performance review, the least affected forest ecosystems, including Southern Jarrah, Karri and Tingle, were in areas of higher or more stable rainfall.
- Areas of 'decline' visible in the southern forests have not been confirmed by field visits, in part due to prioritisation of available resources as there has been no net loss of vegetation cover in ecosystem types that occur in this region (see Jarrah - South, and Karri ecosystem types in Figure 5). Desktop analysis indicates that even though some vegetation cover declined in the reporting period the level is still within the long-term, normal range.

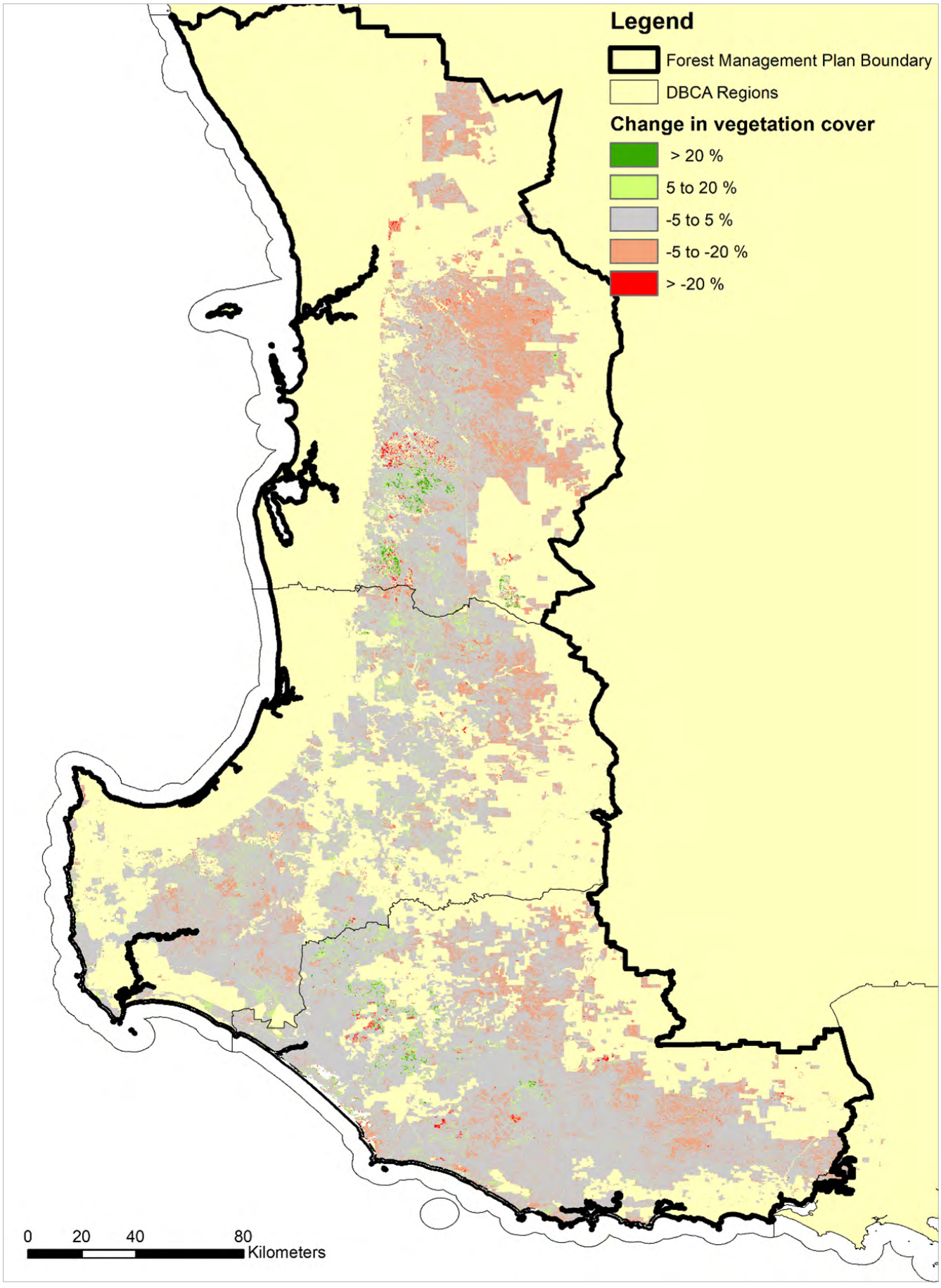


Figure 5. Mean vegetation cover change within the forest management plan area, showing the change in mean vegetation cover between the current FMP period (2014-2021) and the previous FMP period (2004-2013).

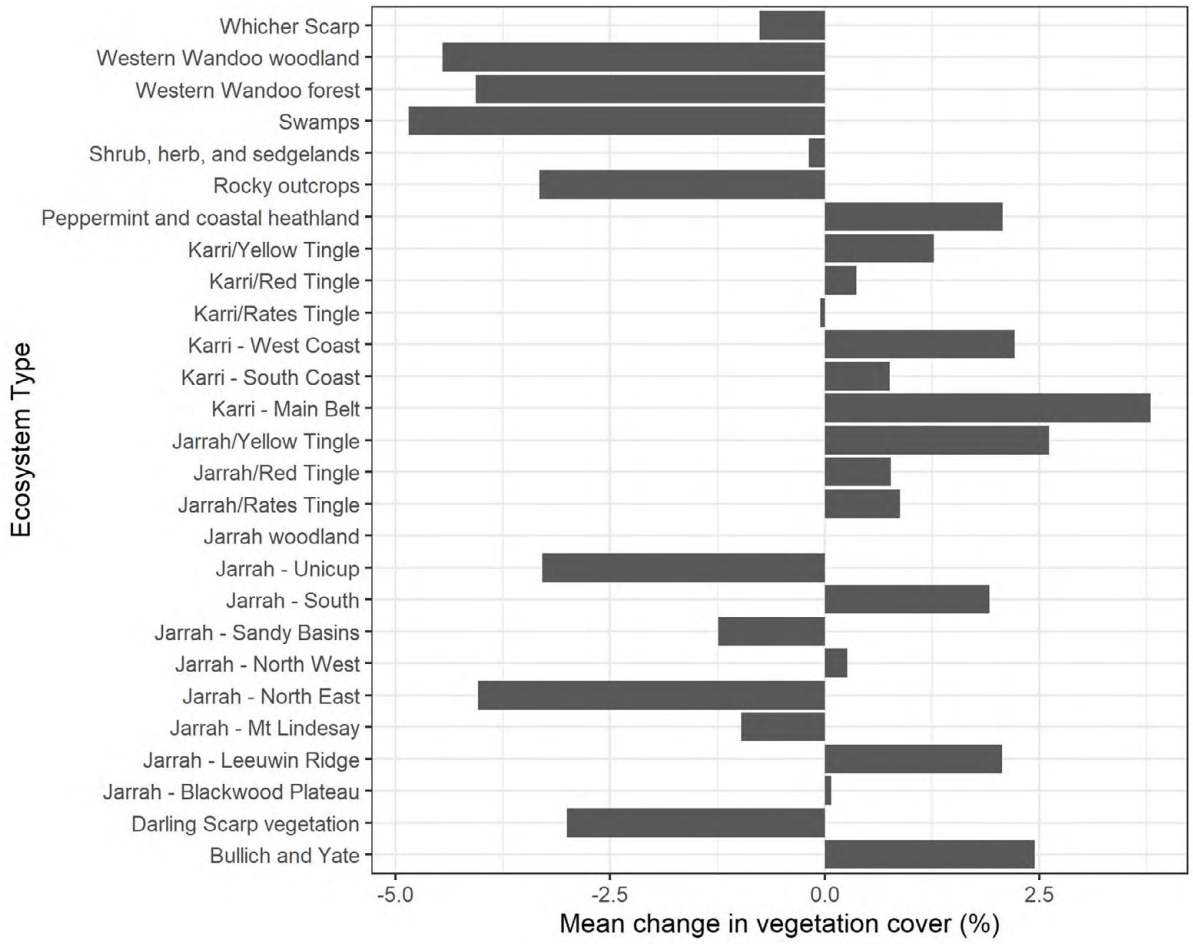


Figure 6. Percentage differences in mean vegetation cover for forest ecosystems between the previous reporting period (2004-2013) and the current reporting period (2014-2021).

CONSIDERATIONS FOR THE NEXT FMP

Monitoring the long-term trends in vegetation cover within forest ecosystems can help assess the relative impacts of climate change on forest health and resilience. Both declines and increases in vegetation cover that are not explained by approved disturbance activities could be used to inform priorities for adaptive management actions designed to promote forest health outcomes. Continued monitoring and attribution of the causes of vegetation cover change should be a component of an overall integrated monitoring framework under FMP 2024-2033.

2.1.2 Reserve System

BACKGROUND

FMP 2014-2023 includes 265 individual proposals for land category changes. If fully implemented, this will result in a reserve system for the FMP area that generally exceeds the minimum standards set under the N*ationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System (CAR) for Forests in Australia* (JANIS 1997).

Where possible, the department manages the areas vested in the CPC consistent with their intended future reservation purpose and relevant departmental policies.

STATUS

Since commencement of FMP 2014-2023, the following FMP proposals for land category change have been gazetted (Table 2).

FMP ID	Reserve Identifier	Gazetted date	Area (ha)
36	36763	1/05/2020	210
52	53649	2/11/2020	19
56	51658	10/03/2014	28
119	40251	15/12/2020	1136
213	53843	15/12/2020	549
			1942

Table 2. Reserves gazetted since the commencement of FMP 2014-2023

Most forest ecosystems are well represented in reserves and are close to target reservation levels. The forest ecosystems that are least well represented, due to impediments to progressing the proposed reservations, include Jarrah North East, and Western Wandoo Forest and Woodland.

MANAGEMENT RESPONSE FOR THIS FMP

The reasons for not implementing new reserves remain the same as those reported in the mid-term performance review. Reasons are mainly due to the South West Native Title Settlement (SWNTS) not being resolved, identified mineral resources and mineral prospectivity, the rights of State Agreement Act mining lessees, and the prioritisation of resources to deliver Government priorities for reservation of conservation lands and waters elsewhere in the State.

The department has focused available resources for progressing land category changes to areas of Government priority, primarily the Plan for Our Parks initiative. This has included finalising the expansion of Wellington National Park, which is in addition to reserve changes proposed in the FMP 2014-2023, and Kalgalup Regional Park. Kalgalup Regional Park Management Plan was approved in 2021 with further work required to formalise the transfer of land parcels to the CPC.

The department continues to manage the areas proposed in FMP 2014-2023 for inclusion in a national park, nature reserve or conservation park consistent with their proposed land category and purpose.

CONSIDERATIONS FOR THE NEXT FMP

All reserve proposals that are in FMP 2014-2023 will be reviewed and, where relevant, carried forward with their current reserve recommendation to the next FMP. The department and the CPC continue to pursue opportunities to progress land category changes proposed in the FMP 2014-2023.

The department will continue to identify priority conservation areas and implement a consultation process for consideration of new reserve proposals, consistent with the Government's policy announcement on 8 September 2021.

2.2 KPI 2 Threatened ecological communities

KPI	Performance target	Year	Achievement	C
2	The target condition of TECs and PECs identified as priorities for management in the relevant regional nature conservation plans	2017	—	M
		2021	—	H

BACKGROUND

FMP 2014-2023 proposed activities at the whole of forest, landscape and/or local scales, for the purpose of promoting resilient ecosystems, including by seeking to protect, and assist the recovery of, threatened and priority ecological communities. Changes in vegetation cover were used as an indicator of condition of threatened ecological communities.

Analysis of the trends in vegetation condition (2008-2017) for 35 threatened ecological communities (TECs) and priority ecological communities (PECs) presented in the mid-term performance review found that 19 ecological communities had stable vegetation cover. The remaining 16 ecological communities showed a decreasing trend in vegetation cover. The major factors that contributed to the decrease included bushfire, declining rainfall and weed invasion.

The CPC acknowledged the significant pressures on TECs and PECs from climate change and other impacts and recommended that the measurement protocols for this KPI be reviewed. The purpose of the review was to ensure that the observed changes in condition had been adequately attributed and managed.

The department presented proposed revisions to the protocol for TECs and PECs to the CPC in April 2020, including that for this end-of-term performance review the protocol would:

– be applied to the same TECs and PECs assessed in the mid-term performance review;
– not address spatial extent; and
– use changes in vegetation condition index from satellite remote sensing to indicate trends in condition, with the method subject to ongoing refinement.

The CPC wrote to the department requesting further information on ground truthing of remote sensing data and measurement protocols for TECs and PECs and the department responded with relevant information.

STATUS

Given the above context, for the end-of-term performance review, two methods have been used to assess changes in vegetation condition within TECs and PECs. The first method is a trend analysis and is the same as that used for the mid-term performance review. This method is based on the change in vegetation cover index as observed from satellite imagery (Landsat) (Table 3). A 10 year period is used to assess the direction and magnitude of vegetation cover change allowing comparison between the period presented in the mid-term performance review (2008-2017) and the current reporting period (2012-2021).

Based on the trend analysis, the condition of the ecological communities remained relatively stable with only one PEC (three per cent of ecological communities assessed) showing a decrease in vegetation cover during 2012-2021.

An alternative methodology, mean vegetation cover change, was also applied as an indicator to assess the condition within a TEC or PEC. This methodology compares the mean vegetation cover level for the previous FMP (2004-2013) with the current reporting period (2014-2021). As outlined in KPI 1, the department considers mean vegetation cover change is the preferred method as it is less influenced by seasonal and short-term variance. Additionally, if the degree of impacts are consistent in both periods, then the mean cover between two time periods will be unchanged. In this approach, comparing the two means shows the net change in vegetation cover.

Using the mean vegetation cover change method, three TECs and two PECs (14 per cent of ecological communities assessed) showed a decrease in vegetation cover and two TECs and one PEC (eight per cent of communities assessed) showed an increase in vegetation cover.

Table 3. Trend in condition of TECs and PECs between the mid-term performance review period (2008-2017) and the current FMP period (2012-2021) and change in mean vegetation cover for the period 2007-2013 and the current FMP period 2014-2021.

Ecological Community (conservation category) * Indicates the community also is part of an EPBC Act listed TEC	Vegetation cover trend analysis		Change in mean vegetation cover[3 4]	Occurrence[5] (Region)		
	2008-2017	2012-2021	2004-2013 2014-2021	S	SW	Wa
Acacia shrublands on taller dunes (P3)	decrease	stable	stable	✓		
Banksia attenuata and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain (EN)*	stable	stable	stable	✓	✓	
Banksia attenuata woodlands over species rich dense shrublands (EN)*	decrease	stable	stable	✓		
Banksia woodlands of the Gingin area restricted to soils dominated by yellow to orange sands (P2)	decrease	stable	stable	✓	✓	
Callitris preissii (or *Melaleuca lanceolata)* forests and woodlands, Swan Coastal Plain (VU)	decrease	stable	decrease [FRU]	✓		
Central northern Darling Scarp granite shrubland community (P4)	stable	stable	stable	✓		
Claypans with mid dense shrublands of *Melaleuca lateritia* over herbs (P1)*	stable	stable	stable	✓	✓	
Coastal shrublands on shallow sands, southern Swan Coastal Plain (P3)	decrease	decrease	decrease [RUW]	✓		
Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain) (CR)*	stable	stable	stable	✓		
*Corymbia calophylla – Eucalyptus marginat*a woodlands on sandy clay soils of the southern Swan Coastal Plain (VU)	stable	stable	increase	✓	✓	
Corymbia calophylla– Kingia australis woodlands on heavy soils, Swan Coastal Plain (CR)*	stable	stable	increase	✓	✓	
Corymbia calophylla – Xanthorrhoea preissii woodlands and shrublands, Swan Coastal Plain (CR)*	stable	stable	stable	✓	✓	
Dense shrublands on clay flats (VU)	stable	stable	stable	✓	✓	
Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (VU)	decrease	stable	decrease [RUI]	✓		
Granite communities of the northern Jarrah Forest (P3)	decrease	stable	stable	✓		
Herb rich saline shrublands in clay pans (VU)*	stable	stable	stable	✓	✓	
Herb rich shrublands in clay pans (VU)*	stable	stable	stable	✓	✓	
Litter-dependant invertebrate community of the northern jarrah forest (P2)	stable	stable	stable	✓		
Low lying *Banksia attenuata* woodlands or shrublands (P3)*	decrease	stable	decrease [RFW]	✓		
Melaleuca huegelii – Melaleuca systena shrublands on limestone ridges (Gibson *et al*. 1994 type 26a) (EN)	stable	stable	stable	✓		
Mount Lindesay – Little Lindesay vegetation complex (EN)	stable	stable	stable			✓
Mount Saddleback heath communities (P1)	stable	stable	stable	✓		
Northern Spearwood shrublands and woodlands (P3)	decrease	stable	stable	✓	✓	
Perth to Gingin Ironstone Association (CR)*	decrease	stable	decrease [FPR]	✓		
Scott River ironstone association (EN)*	decrease	stable	stable		✓	✓
Sedgelands in Holocene dune swales of the southern Swan Coastal Plain (CR)*	stable	stable	stable	✓	✓	
Shrublands and woodlands of the eastern side of the Swan Coastal Plain (CR)*	decrease	stable	stable	✓		
Shrublands and woodlands on Muchea Limestone (EN)*	stable	stable	stable	✓	✓	
Shrublands on calcareous silts of the Swan Coastal Plain (VU)	decrease	stable	stable	✓	✓	
Shrublands on dry clay flats (EN)*	stable	stable	stable	✓	✓	
Shrublands on southern Swan Coastal Plain ironstones (Busselton area) (CR)*	stable	stable	stable		✓	
Southern wet shrublands, Swan Coastal Plain (EN)	decrease	stable	stable	✓	✓	

Ecological Community (conservation category) * Indicates the community also is part of an EPBC Act listed TEC	Vegetation cover trend analysis		Change in mean vegetation cover[3 4]	Occurrence[5] (Region)		
	2008-2017	2012-2021	2004-2013 2014-2021	S	SW	Wa
South-west coastal (Quarram) grasslands (P1)	decrease	stable	stable			✓
Wandoo woodland over dense low sedges of *Mesomelaena preisii* on clay flats (P2)	decrease	stable	stable	✓		
Wooded wetlands which support colonial waterbird nesting areas (P2)	stable	stable	increase	✓	✓	

[3] The change in cover is classified as either a decrease (greater than five per cent loss of vegetation cover), stable (variation within five per cent) or increase (greater than five per cent increase).
[4] F: fire, P: Phytophthora dieback, R: rainfall, U: development, W: weed invasion, I: recreational impacts.
[5] S: Swan Region; SW: South West Region; Wa: Warren Region.

Advice from specialist staff has attributed some of the factors that may have contributed to the change in vegetation cover index, such as bushfire, declining rainfall or development.

Twenty-seven TECs and PECs within the FMP area were not assessed as they are not vegetation-based communities, and the mean vegetation cover method was not applicable.

RATING

The majority of TECs and PECs in the FMP area included in the reporting for the end-of-term performance review had a stable vegetation cover, based on the results of both the trend and mean vegetation cover analyses. This indicates that where a previous decrease in cover was identified during the mid-term performance review, the community had stabilised.

Decreases in mean vegetation cover were largely attributed to bushfire, declining rainfall, *Phytophthora* dieback, and pressure from development. Not all impacts can be managed by the department as the occurrences are either located outside of lands managed under the CALM Act or the impacts are from factors that are beyond the department's control such as climate change and urban development.

MANAGEMENT RESPONSE FOR THIS FMP

Assessment of TECs and PECs under the International Union for Conservation of Nature (IUCN) criteria for listing under the *Biodiversity Conservation Act 2016* has progressed since the mid-term performance review.

The department has continued to monitor the condition of, and threats to TECs and PECs through existing processes and will implement actions to mitigate or manage threats, where feasible.

CONSIDERATIONS FOR THE NEXT FMP

Assessment of conservation status will be undertaken by the WA Threatened Ecological Communities Scientific Committee for consideration by the Minister for Environment.

Preparation of regional conservation plans is underway with completion expected in 2022. The plans will identify prioritised conservation actions to be delivered by regional staff, with support from other sections of the department, to address threats to TECs and PECs.

Mean vegetation cover change could be considered as the preferred indicator of vegetation condition for TECs and PECs. Monitoring should consider the information requirements to ground-truth the trends in condition of TECs and PECs observed through remote sensing analysis.

Further work is required to develop a standardised and achievable monitoring methodology for TECs and PECs, including communities where the condition or extent is unlikely to be determinable through changes to vegetation cover (such as subterranean fauna assemblages).

2.3 KPI 3 Ramsar and nationally listed wetlands

KPI	Performance target	Year	Achievement	C
3	The target condition of Ramsar and nationally listed wetlands as identified in the relevant regional nature conservation plans.	2017	↘	H
		2021	—	H

BACKGROUND

The performance target for this KPI is assessed by reference to ecological character descriptions (ECD) prepared for each Ramsar site. ECDs outline the criteria for listing the site as a wetland of international importance and describe limits of acceptable change (LAC) to quantify the acceptable natural variation for a range of components and processes within the wetland system. Information to assess the Ramsar wetlands against the LAC is drawn from a range of sources including remote sensing, using Landsat imagery to compare changes in inundation and perennial vegetation extent, monitoring of water quality, and flora and fauna surveys.

As reported in the mid-term performance review, between 2013-2017 LAC were exceeded for the five Ramsar sites within the FMP area. Based on the assessment of LAC exceedances, it was concluded that the condition of Ramsar sites was declining. The decline in condition was attributed to pressures from land use change, the drying climate, weeds and increased nutrients. All Ramsar sites in the FMP area, except for Muir-Byenup, are located outside of forest areas and therefore it is not possible to attribute the decline in condition to approved forest disturbance activities.

The CPC recognised the challenge of managing the Ramsar sites and recommended that the department continue working collaboratively with other stakeholders for the management of these areas.

STATUS

Ramsar wetlands are under pressure from a range of processes, such as climate change, loss of surrounding habitat and native vegetation, altered hydrology, deteriorating water quality, invasive weeds, feral animals and uncontrolled access. LAC are being regularly exceeded in four Ramsar sites: Becher Point, Forrestdale and Thomsons Lakes, Vasse-Wonnerup and Muir-Byenup (Table 4). No LAC were exceeded in the Peel-Yalgorup site.

All five assessed Ramsar sites maintain a majority of the values that have been recognised as being of international importance under the *Convention on Wetlands of International Importance* (Ramsar Convention). Despite the LAC indicating a declining trend in wetland condition, the five Ramsar sites assessed have retained the values recognised in their listing and their ecological character under the Ramsar Convention.

The number of LAC reported differs between the mid-term performance review (2014-2017) and the current period (2017-2021) due to varying levels of data collected.

Ramsar wetland	LAC regularly exceeded	Comments
Becher Point	2/10	LAC were met for eight of the 10 criteria. Two of the LAC, total nitrogen and phosphorus in groundwater, were exceeded from 2014-2021.
Forrestdale & Thomsons Lakes	8/20 & 6/20	LAC were exceeded for annual maximum water depth from 2014-2021 at Forrestdale Lake and in 2016 and 2017 at Thomsons Lake. The period of drying exceeded the LAC at Forrestdale Lake in 2020 and dried earlier than the LAC in 2014, 2018-2020. At Thomsons Lake the period of drying has not been recorded however, the lake dried earlier than the LAC in 2016 and 2019. Salinity exceeded the LAC in 2015, 2017, 2019 and 2020 at Forrestdale Lake and in 2014, 2015 and 2017 at Thomsons Lake. Total nitrogen exceeded the LAC at both lakes from 2014-2021. Based on waterbird counts in 2020 and 2021, the lakes are not supporting sufficient numbers of waterbirds for the LAC to be met. Both lakes are drying for longer periods, and this has led to the encroachment of *Typha orientalis* (bullrush) across the lake beds.
Peel-Yalgorup	0/13	Between 2014-2017, LAC were exceeded for salinity, chlorophyll a, nutrients, waterbirds, littoral vegetation and phytoplankton. From 2017-2021, no LAC were exceeded. The rising salinity in Yalgorup lakes has the potential to impact on thrombolite communities. There are trends towards significant deterioration in water quality and loss of fringing vegetation.
Vasse-Wonnerup	12/22	LAC were exceeded for inundation over summer, water depth and flood gate operation, total phosphorus, dissolved oxygen, ammonium, pH levels, biomass levels, community structure and species composition and waterbird breeding success. From 2014-2017 and in 2021, fish deaths occurred. Salinity in the Wonnerup estuary rose to 60 parts per thousand (ppt) in late summer and 100 ppt in the Vasse Estuary or more than 3 times sea water concentration. Waterbird LAC are being met in most years. The change in the operation of the flood gate in 2014 has created higher summer water levels and lower winter levels from 2014-2021. Higher summer water levels in 2017-2021have resulted in a loss of wader habitat.
Muir-Byenup	5/15	LAC were exceeded for water depth (drying out) and pH in Tordit-Gurrup in 2013-2021 due to reduced rainfall in the catchment and reduced groundwater discharge. The LAC for total nitrogen was exceeded for all lakes in the Muir-Byenup system. All lakes showed signs of decline in inundation due to the drying of wetlands, which in turn can increase the acidity of the lakes.

Table 4. Summary of influences on the condition of Ramsar wetlands.

RATING

- Alteration has occurred in a portion of some of the wetland systems, however aquatic components, processes and ecosystem values of international importance continue to be supported in all Ramsar wetlands (Table 5). Examples are the acidification of the Tordit-Gurrup Lagoon within the Muir-Byenup Ramsar site; the deteriorating water quality within the Serpentine and Murray rivers draining to the Peel Harvey estuary; increasing salinity within the Yalgorup lakes; and the increased marine exchange within the Vasse estuary as a result of altered floodgate management controlling the exchange of seawater.
- The drying climate influence is evident across all wetlands. The most significant impact has been the exposure of lake sediments with high levels of sulphidic compounds which has led to acidification of some lakes within the Muir-Byenup Ramsar site. Acidification in Lake Mealup (Peel-Yalgorup Ramsar site) has been avoided through the construction of a weir on the Mealup main drain to manage water levels.
- Wetlands in proximity to urban areas show declining condition in response to factors including eutrophication, groundwater abstraction, unmanaged access and the introduction of weeds.

Ramsar wetland	Summary condition
Becher Point	The Becher Point Ramsar site is listed for being a representative of shrub swamps and seasonal marshes in good condition. It continues to support two nationally listed threatened ecological communities and a State priority ecological community. The incidence of bushfire at Becher Point, combined with declining groundwater levels in the northern and eastern sections of the site and continued unauthorised access by off-road vehicles has led to unnatural surface flow, erosion and weed invasion along the access tracks that have spread to conservation significant values. Beach erosion is also occurring. LAC are regularly exceeded for the concentration of total nitrogen and phosphorus in groundwater. These elevated nutrient levels can be associated with water abstraction and fertiliser use in surrounding areas.
Forrestdale and Thomsons Lakes	Forrestdale and Thomsons Lakes meet the two listing criteria under the Ramsar Convention as the best remaining examples of large brackish, seasonal lakes with extensive fringing sedgeland typical of the Swan Coastal Plain, within the South-West Coast Australian Drainage Division. The lakes continue to provide important habitat for waterbirds on the Swan Coastal Plain, including migratory species. LAC are exceeded for annual maximum water depth and the date of first drying, salinity within Forrestdale Lake, total nitrogen and the abundance and number of breeding waterbird species. Both lakes are drying for longer periods each year leading to encroachment of *Typha orientalis* on the lake beds, resulting in unsuitable wetting regimes for the survival of cygnets. Drying climate and urbanisation are key threats, along with a large kangaroo population impacting on the vegetation within Thomsons Lake Nature Reserve. From 2012-2020, remote sensing indicates there has been an 18 per cent decline in vegetation within the catchments of both lakes.
Peel-Yalgorup System	The Peel-Yalgorup site continues to meet seven listing criteria under the Ramsar Convention. The site continues to support threatened species and ecological communities, wetland dependent birds, native fish, micro-algae and a population of Indo-Pacific bottlenose dolphins. Thirteen new LAC were established for the Peel-Yalgorup system within the Draft Ecological Character Description Addendum (Hale 2019) and these were not exceeded between 2014-2021. Significant pressures from the drying climate are impacting the hydrological drivers across the wetland system including warm, low oxygen waters and seasonal fish deaths within the Serpentine and Murray rivers. Rising salinity in the Yalgorup lakes is having an as yet unquantified impact on thrombolite and other microbial communities. Black swans have disappeared from Lake Pollard as conditions are unsuitable to support the growth of its main food source, fox stonewart.
Vasse-Wonnerup System	The Vasse-Wonnerup Ramsar site continues to meet the two listing criteria under the Ramsar Convention, including the regular support of waterbird numbers exceeding 20,000. Monthly counts recorded 71,789 waterbirds across 2020, from 66 species. The site regularly (five out of seven years) supports one per cent of the biogeographic population of red-necked avocets, Australian shelduck, Australasian shoveler and pied stilt. The median summer inundation for the Vasse and Wonnerup estuaries showed an increase compared to the pre-2014 long-term average, as a result of a changed gate operation regime. The increase in water levels in the Vasse estuary was three times larger than the Wonnerup estuary. The maximum inundation for the Vasse estuary was also significantly above the historic range. This has resulted in reduced wader habitat and the numbers of waders show a steep decline within the Vasse estuary.
Muir-Byenup System	The Muir-Byenup Ramsar site continues to meet the six listing criteria under the Ramsar Convention, including being the best example of partly inter-connected wetlands that range in size, salinity (saline to fresh), water permanence (permanent to seasonal) and substrate (peat and inorganic), in an internally draining catchment in relatively undisturbed condition in the South-West Coast Australian Drainage Division. The peat-based wetlands within the site are rare in Western Australia. LAC were exceeded for water depth (drying out), pH and total nitrogen in Tordit-Gurrup Lagoon in 2013-2021 due to reduced rainfall in the catchment and groundwater discharge. Significant drying has impacted permanently inundated wetlands and has led to a 41 per cent reduction in inundation from a baseline established between 1988-2010. Total nitrogen in all assessed lakes exceeded the Australian and New Zealand Guidelines for Freshwater trigger level of 1.5 mg/L (ANZECC and ARMCANZ 2000). To date, the Tordit-Gurrup Lagoon is the only lake within the Ramsar site boundary that has become acidified.

Table 5. Summary of condition of Ramsar wetlands.

MANAGEMENT RESPONSE FOR THIS FMP

Since completion of the mid-term performance review the department, with other government agencies and stakeholders, has undertaken management actions to mitigate pressures on wetland condition including:

i. water supplementation at Thomsons Lake since 2006 allowing water levels to reach a maximum depth during winter. Opportunities for water supplementation at Forrestdale Lake from nearby drains are currently being investigated in partnership with State agencies and local government.

ii. to maintain summer water levels, manage algal blooms and prevent fish deaths, the operation of the surge barrier for the Vasse-Wonnerup system has changed allowing flushing with seawater.

iii. a water quality monitoring program commenced in the Yalgorup Lakes in 2019. A research program to characterise the extent, status and system requirements of the microbial communities within Lake Clifton has also commenced.

iv. weed control at Becher Point, Forrestdale and Thomsons Lakes, Peel-Yalgorup and Vasse-Wonnerup systems, has been undertaken where necessary, within available resources.

CONSIDERATIONS FOR THE NEXT FMP

The department, in collaboration with other government agencies, will continue to undertake management actions and prioritise work to assist in adaptation to changing climate pressures and mitigating pressures on wetland condition.

Monitoring is required to assist in decision making to limit the impacts of climate change on the Ramsar wetlands. Prioritisation of management and mitigation actions is expected to occur through preparation and implementation of regional conservation plans that will inform amendments to the measurement protocols for Ramsar wetlands.

For the FMP area, consideration should be given to amending the monitoring protocol to focus on wetlands that are likely to be affected by the department's management activities.

2.4 KPI 4 Threatened flora

KPI	Performance target	Year	Achievement	C
4	(Change in flora populations for species) defined in the relevant regional nature conservation plans.	2017	—	L
		2021	↘	L

BACKGROUND

FMP 2014-2023 proposes activities at the whole of forest, landscape and/or local scales, for the purpose of promoting resilient ecosystems, including by seeking to protect, and assist the recovery of threatened and priority flora.

Biological surveys of threatened and priority listed flora species are undertaken by the department with the results recorded in a database. This information can be used to assist in evaluating the extent to which biodiversity is being conserved.

It was recognised in the mid-term performance review that changes in the number of listed species could be due to an increase in the knowledge of the species and may not be an indication of the overall state of flora having declined. A species may have been listed because new information collected allows its conservation status to be more clearly defined or it may have been listed because of taxonomic revision.

The CPC acknowledged that there were a range of factors influencing the threatened flora population sizes and recommended further information be provided detailing the measurement and analysis of changes in population number and/or size for flora listed as critically endangered.

The department presented further information to the CPC in July 2021, recognising that survey and management effort are not consistent for all threatened species or individual populations of a particular species. For the 42 species listed as critically endangered, 14 recorded a decrease in population size from 2008-2017.

STATUS

The number of flora species listed as threatened within the FMP area increased from 120 in 2013 to 125 in 2017. The number of threatened flora species in 2021 remained at 125. The number of listed priority species increased from 526 in 2013 to 549 in 2017, and 568 in 2021 (Table 6). No extinctions were recorded between 2017-2021.

Region	Year	Total number of species listed	Critically endangered	Endangered	Vulnerable	Extinct	Priority
Swan	2013	364	21	21	27	2	293
	2017	366	21	23	26	3	293
	2021	377	20	24	26	3	304
South West	2013	269	22	18	12	2	215
	2017	269	22	19	12	2	214
	2021	274	22	19	12	2	219
Warren	2013	212	7	8	8	0	189
	2017	214	6	10	8	0	190
	2021	216	6	10	8	0	192
Total in FMP area	2013	649	44	33	43	3	526
	2017	679	42	44	39	5	549
	2021	698	41	45	39	5	568

Table 6. Listing status of threatened and priority flora species at 2013, 2017 and 2021.

During the reporting period, one threatened species' threat category was reduced. In 2018, *Caladenia hopperiana* changed category from critically endangered to endangered within the Swan region. This change was due to the discovery of new populations. The populations are fragmented through creek systems and are still under threat due to the decline in habitat condition.

Between 2017-2021, the number of priority listed flora species in all regions increased. These increases were due to a range of factors including increased knowledge about species, new species identified, or other reasons such as disturbance of a known population.

For the period 2017-2021, 43 species (17 in the South West, 16 in Swan and six in Warren region, three that occur in both Swan and South West and one that occurs in both South West and Warren Regions) of critically endangered or endangered flora species were monitored across the three FMP regions. Nine species recorded a decline in population, 17 were recorded as stable and 17 increased.

RATING

The manner in which the monitoring was undertaken between the mid-term and end-of-term reporting periods did not vary. Variations occurred in the monitoring effort for each species and changes in the knowledge for each species. As outlined in the mid-term performance review, population size variations and changes can be the result of a range of factors such as time since last fire.

MANAGEMENT RESPONSE FOR THIS FMP

The department has continued to implement survey and monitoring of threatened flora populations. Preparation of regional conservation plans is underway with completion expected in 2022. The plans will identify prioritised conservation actions to be delivered by regional staff, with support from other sections of the department, to address threats to threatened and priority flora.

CONSIDERATIONS FOR THE NEXT FMP

Consistent monitoring protocols and the completion of the regional conservation plans will inform the management activities and KPIs for the next FMP. If threatened flora are monitored, a prioritisation framework and protocols could be developed to ensure consistency across the three regions.

[6] The Western Shield program, which aims to protect threatened fauna from introduced predators such as foxes and feral cats, is applied over approximately 86 per cent of the area managed by the department in the FMP area. Additional smaller scale feral cat control has also been undertaken as part of research programs.

2.5 KPI 5 Threatened fauna

KPI	Performance target	Year	Achievement	C
5	(Change in fauna populations for species) defined in the relevant regional nature conservations plans	2017	↘	M
		2021	↘	M

BACKGROUND

Biological surveys of threatened and priority listed fauna species are undertaken by the department to understand their conservation status and inform management actions to recover and protect these species. Long-term monitoring has been conducted under the Western Shield program[6] and in the Upper Warren area including Tone-Perup Nature Reserve, Greater Kingston National Park and surrounding State forests.

Monitoring undertaken for the department's FORESTCHECK program indicated that forest biodiversity is largely resilient to disturbance from silvicultural operations. The CPC noted that declines in the populations of some species had not been attributed to a particular cause or threat category. To assist in ascertaining if further specific management responses may be required, the CPC recommended further information on the measurement and analysis of change in population and/or size as a function of time be provided for key threatened fauna.

The department provided further information to the CPC in July 2021 outlining the monitoring results for Western Shield for 2018 and 2019, the results of the Great Cocky Count in 2019, and information on populations of the sunset, white-bellied and orange-bellied frogs. This information was noted by the CPC.

Monitoring of indicator species through Western Shield and the Upper Warren project has provided data for reporting on this KPI. While this information cannot be used to attribute observed trends to specific management activities within the FMP area, it provides an understanding of the trends at the species level.

This information is used in assessing the status of threatened and priority species of fauna in the FMP area. Results presented for the mid-term performance review identified an increase in the number of fauna species listed as threatened or specially protected from 112 in 2013 to 120 in 2017.

STATUS

Within the FMP area, the total number of fauna species listed as threatened or priority, increased from 112 in 2013, to 120 in 2017 and to 123 in 2021 (Table 7).

A taxonomic revision of the shield-backed trapdoor spider (*Idiosoma nigrum*) resulted in multiple new species being described, three of which are within the FMP area and have subsequently been added to the priority fauna list. There have also been changes to the category of some species during the reporting period (2017-2021). The conservation status of the shield-backed trapdoor spider was changed from vulnerable to endangered due to the recalculated species distribution after the taxonomic revision. Douglas's broad-headed bee (*Hesperocolletes douglas*i) was rediscovered, removed from the list of extinct fauna and listed as critically endangered.

Monitoring of the four Western Shield indicator species, woylie (*Bettongia pencillata ogilbyi*), koomal (*Trichosurus vulpecula*), chuditch (*Dasyurus geoffroii*) and quenda (*Isoodon fusciventer*) during the current FMP period (2014-2021) showed a decreasing trend for koomal, chuditch and quenda. There has been an increase in the relative abundance of woylies in recent years, however their relative abundance remains lower than their peak in the early 2000s (Figure 7).

The trends reported in the mid-term performance review for the long-term monitoring of mammals in the Upper Warren[7] area have continued, including:

- an increase to the late 1990s and subsequent decline from around 2000 to present for the Western Shield indicator species;
- the decline of brush-tailed phascogales (*Phascogale tapoatafa*), two species of dunnart (*Sminthopsis* spp.), southern bush rat (*Rattus fuscipes*) and western brush wallaby (*Notamacropus irma*);
- increases of koomal and tammar wallabies (*Macropus eugenii*), since the mid-2000s to 2013 (Wayne 2018), as reported in the mid-term performance review. However, since 2013 koomal have subsequently declined; and
- gradual increases in chuditch populations in the early 2000s have not been sustained and the populations have continued to decline since 2013.

[7] Fauna monitoring results for the Upper Warren area are included in the Western Shield dataset.

Region	Year	Total number of species listed	Critically endangered	Endangered	Vulnerable	Extinct	Priority	Conservation dependent
Swan	2013	79	3	11	22	2	41	N/A
	2017	76	4	15	17	2	35	3
	2021	86	8	17	17	2	40	2
South West	2013	62	5	10	17	4	26	N/A
	2017	71	6	15	17	5	25	3
	2021	76	8	15	16	5	29	3
Warren	2013	47	2	6	14	2	23	N/A
	2017	60	3	15	17	2	21	2
	2021	58	5	14	14	2	21	2
Total in FMP area	2013	112	7	16	28	7	54	N/A
	2017	120	8	25	25	8	50	4
	2021	123	11	24	21	8	56	3

Table 7. Listing status of threatened or specially protected fauna species at 2013, 2017 and 2021.

Note that the total number of species in each category of Table 7 is not an addition of the numbers of species in each of the three FMP regions, as some species occur in more than one region.

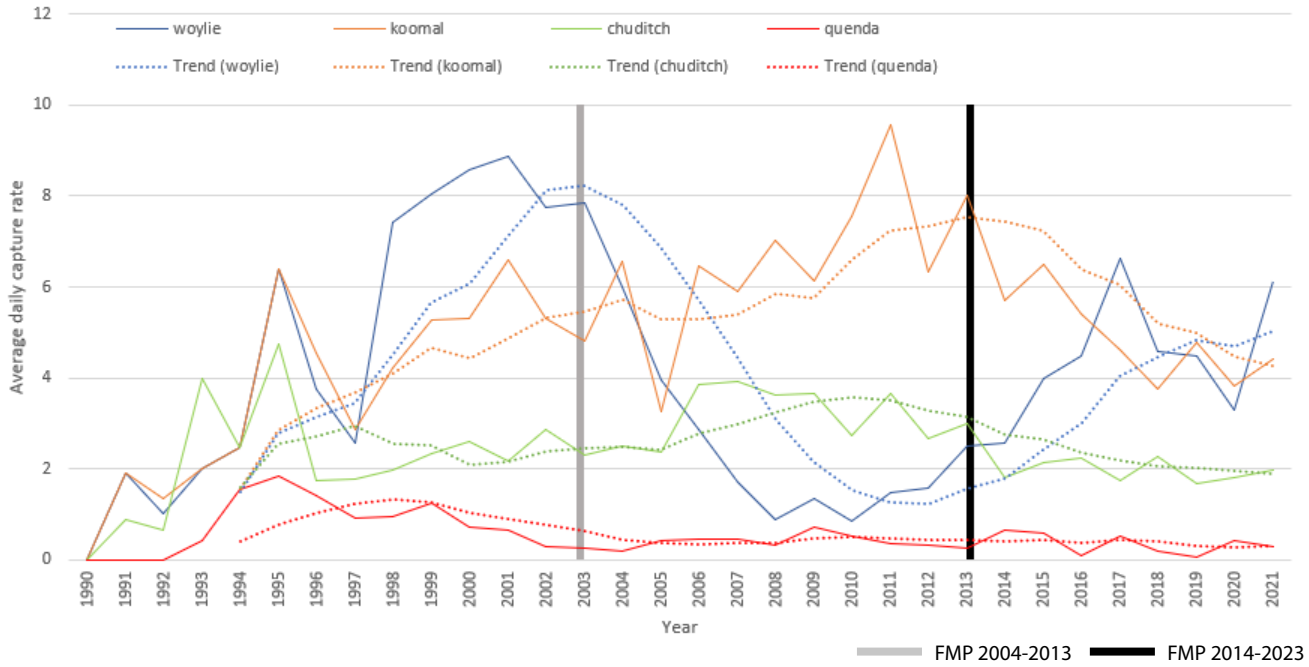


Figure 7. Average daily capture rates of key Western Shield indicator species monitored within the FMP area between 1990 and 2021. Trend lines represent a 5-year moving average.

RATING

The declining trend for populations of native fauna indicator species has continued through the FMP period (2014-2021).

The mid-term performance review identified that pressures from invasive species and disturbance activities, including fire both prescribed and bushfire, may affect fauna populations. It was identified that while timber harvesting may have localised and temporary impacts on fauna abundance and population stability, habitat removal through land clearing will permanently displace species from an area.

Additional species identified as priorities in the FMP area showed varied population trends during the reporting period including:

- The population estimates for the forest red-tailed (*Calyptorhynchus banksii*), Carnaby's (*Calyptorhynchus latirostris*), and Baudin's black cockatoos (*Calyptorhynchus baudinii*), within the FMP area show variation between the species. Monitoring of Carnaby's cockatoos through the most recent published results of the Great Cocky Count (Peck *et al*. 2019) indicates a decline in the population to 2015 with the population being approximately constant to 2019. The forest red-tailed black cockatoo has demonstrated an increase in the greater Perth metropolitan area coinciding with an apparent increase in the species' use of the Swan Coastal Plain. The Great Cocky Count has a focus on the greater Perth metropolitan area and the results provide less guidance on the potential changes in populations of the three black cockatoo species across the larger FMP area.
- Maintenance of populations of western swamp tortoise (*Pseudemydura umbrina*) as a result of management activities to mitigate impacts of threatening processes at Ellen Brook Nature Reserve and supplementation of other populations from captive bred animals.
- Amphibians monitored were sunset (*Spicospina flammocaerulea*), white-bellied (*Geocrinia alba*), and orange-bellied frogs (*G. vitellina*). The sunset frog has 400 known individuals with a stable population since 2017. Prior to this period the species was declining, although not as a result of approved forest activities. Translocated sub-populations have subsequently offset the loss of other sub populations. The number and abundance of white-bellied and orange-bellied frog populations continues to decline linked to changed hydrology and reduced rainfall. The establishment of new populations through translocations and conservation introductions, though successful, has not offset the loss of natural populations.
- The abundance of migratory shore birds recorded at the Vasse Wonnerup Ramsar site has declined since 2014 and has continued to decline to 2021 after a short period of the populations remaining stable. These declines are likely due to local (e.g. changes to local water management regimes impacting availability of feeding habitat) and flyway-wide (e.g. habitat loss throughout the international flyway) pressures.

MANAGEMENT RESPONSE FOR THIS FMP

Management actions including fire management, feral and pest animal control, *Phytophthora* dieback control, fencing, signage, and translocations were undertaken to protect threatened and priority fauna populations across the FMP area.

As outlined in the mid-term performance review, management actions undertaken as part of the Western Shield program, and local baiting programs in the FMP area are critical in minimising the impact of predation by foxes and feral cats on threatened fauna, especially in areas subject to disturbance. Ongoing frequent management of introduced predators is critical to contributing to the continued persistence of many populations of threatened fauna in the FMP area.

From a biodiversity perspective, prescribed burning continues to be undertaken to maintain a range of wildlife habitat types through the creation of low-fuel areas in a mosaic of burnt and unburnt patches across the landscape. Where practicable, local scale operations consider appropriate measures to minimise loss of legacy habitat elements (such as tree hollows and fallen, hollow logs) (DBCA and DFES 2020).

Threatened fauna recovery was facilitated through the coordination of species-based recovery teams that include Government and non-government organisations, industry representatives and community members.

Preparation of regional conservation plans is underway with completion expected in 2022. The plans will identify prioritised conservation actions to be delivered by regional staff, with support from other sections of the department, to address threats to threatened, specially protected and priority fauna.

CONSIDERATIONS FOR THE NEXT FMP

The department will seek to:

- enhance introduced predator management for the conservation of native species to reduce predation pressure on vulnerable native fauna.
- continue to develop strategic partnerships and programs with recreational hunting and other groups to augment the resources available for targeted pest animal control to reduce the threat they present to key fauna species.
- develop improved monitoring, evaluation and reporting procedures and data management systems.
- maintain a pest animal science capability and work collaboratively with other agencies and institutions to enhance management effectiveness and identify novel strategies for pest animal management.

2.6 KPI 6 Distribution of fire age

KPI	Performance target	Year	Achievement				C
6a	Conformance to the theoretical distribution of time since fire for the whole of forest.	2017				—	M
		2021				↗	M
6b	Conformance to the theoretical distribution of time since fire for major land management units.	2017			—		M
		2021			—		M

BACKGROUND

FMP 2014-2023 aims to promote resilient and healthy forest ecosystems that have an appropriate distribution of forest fuels that help to maintain ecosystem condition. The FMP area is separated into 32 landscape management units[8] (LMUs) (Figure 8).

For each LMU, a theoretical negative exponential function based on inputs relating to the life history attributes and ecological requirements of native vegetation (McArthy *et al*. 2001) provides the target distribution of 'time since fire'. The degree to which the fuel age distribution for each LMU conforms to the theoretical negative exponential curve, indicates how well the fire management performance target is being achieved.

The mid-term performance review reported on the fuel age distribution for the 2016-17 fire season as data was not available prior to this. The information presented for LMUs demonstrated that the distribution of forest fuel age ranged from zero to greater than 45 years and that structural diversity was maintained across the landscape.

The CPC requested further information on the conformance to the theoretical distribution of 'time since fire' for each LMU. Graphs for each of the LMUs showing the distribution of actual fuel age (at July 2017) against the ideal fuel age or theoretical distribution curve were presented to the CPC in October 2019. The impacts of large bushfires, the influence of adjoining land tenures requiring burning to be tailored to strategic protection and use of more flexible approaches to prescribed burning to achieve more evenly distributed fuel ages were outlined.

STATUS

The department continues to develop, maintain and resource the prescribed burn program. This assists in preventing large-scale bushfires and creates a mosaic of fuel ages at a landscape and local level. This targeted approach has allowed prescribed burns close to human populations and assets at risk from high fuel ages to be undertaken.

The fuel age distribution for the FMP area for the whole-of-forest shows correlation with the negative exponential curve with some skew towards the younger fuel age classes (Figure 9). This is due to large bushfires in 2014-15 and 2015-16 as well as increased prescribed burning in 2016-17. Areas treated with prescribed fire result in a mosaic of burnt and unburnt areas and different burn intensities within the burn area, although the total area treated is reported.

The unknown fuel age category relates to small parcels of land on the forest periphery or areas incorporated into the forest estate where fuel records do not exist. It also includes areas where fuel is not present, such as mine pits, lakes and sand sheets.

[8] Land management units are an agglomeration of vegetation complexes and ecological vegetation systems, as defined and mapped by Mattiske and Havel (2002), to form more compact management units that recognise the underlying ecological characteristics.

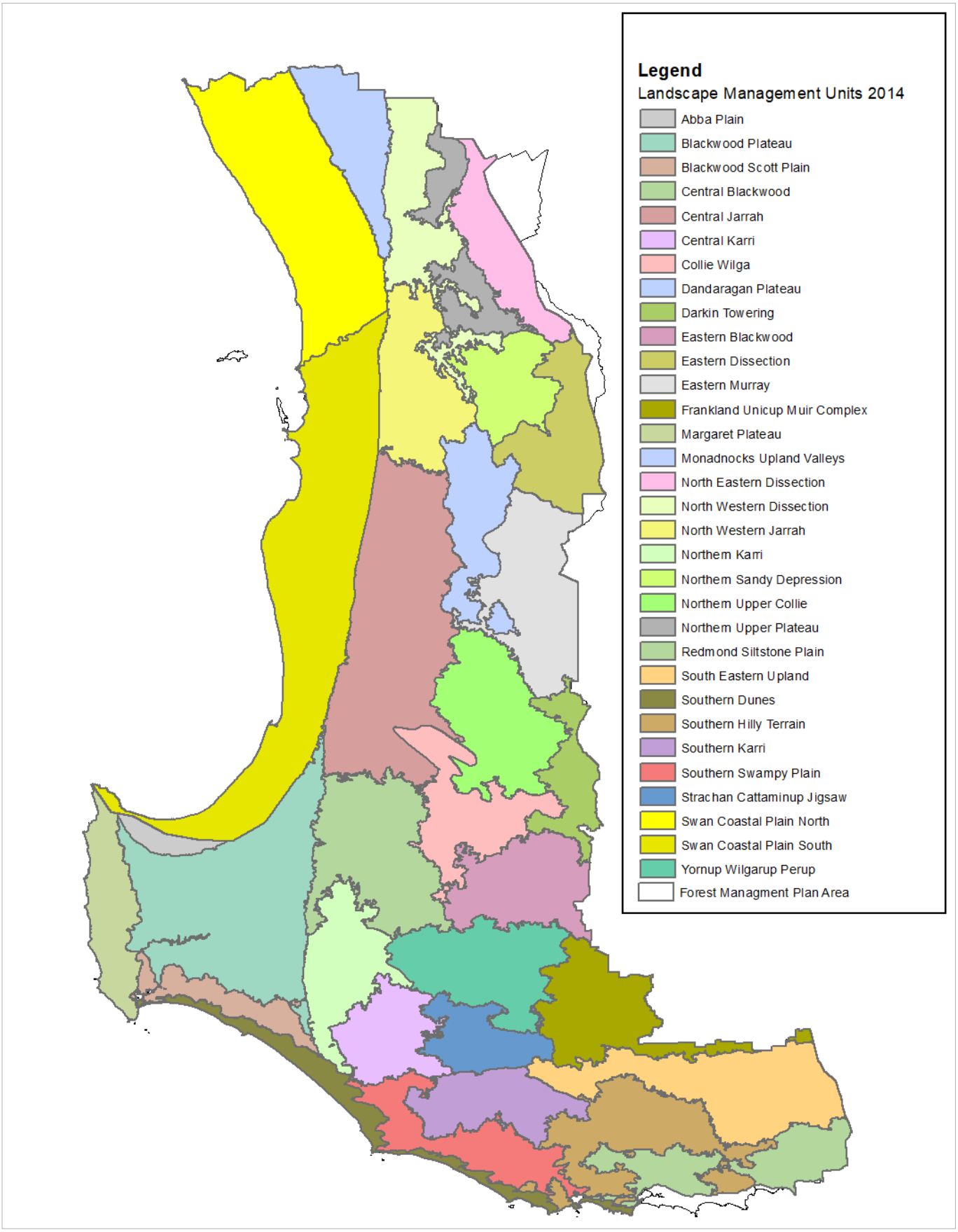


Figure 8. Landscape Management Units in the Forest Management Plan area.

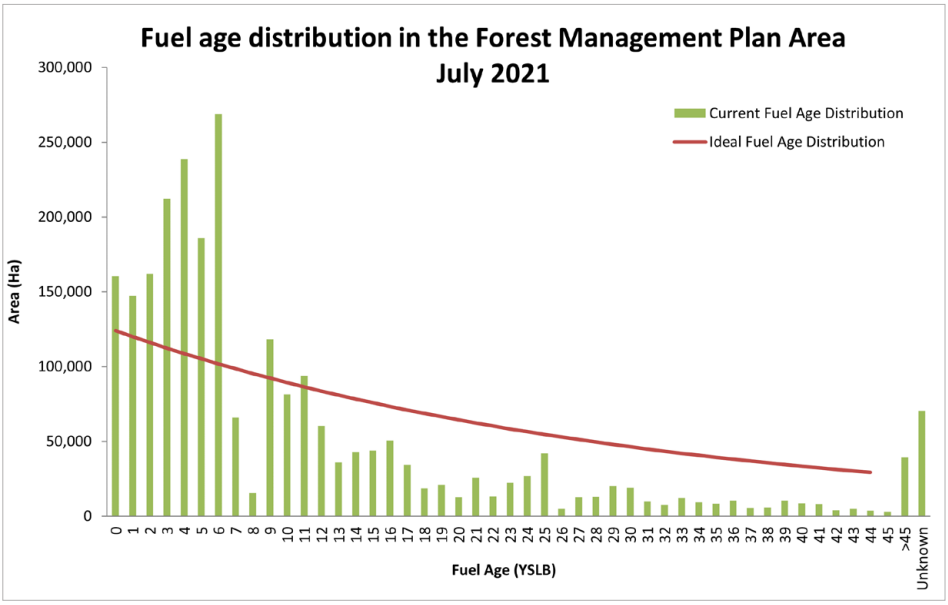


Figure 9. Fuel age distribution in the FMP area (July 2021).

Review of the fuel age distribution for the LMUs that are sufficiently large and contiguous demonstrate general conformance with the negative exponential curve (Table 8).

Landscape Management Unit	Comments on conformance with negative exponential curve
Blackwood Plateau	Generally conforms.
Central Blackwood	Generally conforms.
Central Jarrah	Generally conforms.
Central Karri	Curve skewed to fuels older than 21 years reflecting sub-optimal prescribed burning outcomes, and absence of large bushfires, in this LMU over the last decade. Areas of fire-sensitive karri regrowth influence the prescribed burning outcomes.
Collie Wilga	Generally conforms.
Frankland Unicup Muir Complex	Generally conforms.
Monadnocks Upland Valleys	Generally conforms.
North Western Jarrah	Generally conforms. Exceptions are most noticeable in the 0-6 year old fuel classes due mainly to bushfires.
Northern Karri	Generally conforms. Exceptions in the 20–25-year-old fuel categories are due to the impact of karri regrowth areas on prescribed burning.
Northern Sandy Depression	Generally conforms. Exceptions are most noticeable in the 3-4 year old fuel class due mainly to prescribed burn program implementation.
Northern Upper Collie	Generally conforms. A notable exception is the 6 year old class that is due to a major bushfire event in 2014-2015.
Redmond Siltstone Plain	Large proportions of fuel occur in the younger fuel age classes due primarily to large prescribed burns for strategic protection.
South Eastern Uplands	Generally conforms. Skew to younger fuel ages due mainly to prescribed burn program implementation.
Southern Dunes	Generally conforms, with several exceptions over the last decade due to large bushfire events.
Southern Hilly Terrain	General conformance with the curve but skewed to fuels less than 10 years old, due to a combination of prescribed burning and bushfires.
Southern Karri	Over 50 per cent of this LMU consists of 6-year-old fuel arising from a major bushfire in 2014-2015. Other fuel age classes generally conform with the curve.
Southern Swampy Plain	Generally conforms. Principal exception is in the 6 year old fuel class resulting from a major bushfire event in 2014-2015.
Strachan-Cattaminup Jigsaw	Generally conforms with higher fuels in the 13-17 year old fuels due to mixed land uses and strategic protection imperatives.
Yornup Wilgarup Perup	Generally conforms with the curve, with increased areas of younger fuels due to post-harvest and strategic protection prescribed burns.

Table 8. Conformance of fuel age classes in major LMUs with the negative exponential distribution.

RATING

Whilst there is general conformance with the negative exponential curve at whole-of-forest scale, the younger fuel ages represented are due to large bushfires during this FMP and large areas burnt under prescription notably between 2016-2019.

During the FMP period (2014-2021), large bushfires impacted on the Central Jarrah, Blackwood Plateau, Collie Wilga and Swan Coastal Plain LMUs. The continuing trend toward large landscape-scale bushfires has also influenced the conformance of LMUs with the negative exponential curve. Lower levels of prescribed burning, due to unsuitable burning conditions and a drying climate have contributed to this trend.

Karri regrowth is susceptible to fire impacts until about 25 years and so is excluded from prescribed burning treatments. Consequently, in both the Northern and Central Karri LMUs, the curves are skewed towards fuel ages between 15-25 years old. Seasonal variability, fuel conditions and unfavourable weather can also affect the prescribed burn program, which may leave some areas outside the curve.

MANAGEMENT RESPONSE FOR THIS FMP

The department has increased the amount of prescribed burning that has been conducted during the term of this FMP. More recently, the application of additional, highly mobile resources has facilitated a more flexible approach to the implementation of the prescribed burning program. This has reduced the potential for landscape scale bushfires as the large contiguous patches of even aged fuel areas are broken up providing a mosaic of fuel ages across the landscape.

Work continued to be undertaken to incorporate the prescribed burning and timber harvesting (and mining) activities to achieve an optimal outcome for both. Prescribed burning in karri has continued and areas of suitable age to withstand fire have been incorporated into larger prescribed burning areas with appropriate and necessary precautions to avoid any detrimental impacts that may occur from the burn.

CONSIDERATIONS FOR THE NEXT FMP

- Maintain implementation of prescribed burning programs to represent the negative exponential curve as closely as practicable with outcomes that contribute to the creation and maintenance of a landscape-scale mosaic that aims to reduce the prevalence and impact of major bushfires.
- Maintain the program of introducing prescribed fire into karri regrowth stands to address over-representation of moderate fuel ages in relevant LMUs.
- Integrate planning of prescribed fire and forest ecosystem management actions to facilitate the re-introduction of prescribed fire into regrowth areas.
- Integrate post-burn severity mapping techniques to better quantify prescribed burn outcomes and highlight fine scale mosaics being achieved through the use of managed fire.

2.7 KPI 7 Effectiveness of fire planning and management

KPI	Performance target	Year	Achievement	C
7.1	90 per cent of prescribed burns that meet their stated objective.	2017	—	M
		2021	↗	H
7.2	Completion of the relevant regional fire management plans by mid-term.	2017	—	H
		2021	Not applicable	

BACKGROUND

Prescribed burning is a key operational tool that the department uses to achieve fuel reduction at the landscape scale. Each burn prescription has an objective, a set of goals and outcomes to be achieved that are related to the values associated with the area. Individual burn outcomes may not meet the specified objectives due to variations in physical and environmental factors at the time of implementation.

In the mid-term performance review, the department reported on 33 per cent of prescribed burns conducted during 2016-17. Of these, 68 per cent of prescribed burns achieved their objective, 31 per cent partially achieved the objective and one per cent did not achieve the objective in the burn prescription. Each burn will have an overarching objective to be met and this is measured using success criteria. It is possible for a burn to meet its objective when some of the success criteria are not achieved.

The CPC acknowledged the work of the department to meet the performance target relating to regional fire management plans and recommended that the KPI be reviewed. The department advised the CPC in April 2020 that the Bushfire Risk Management Framework had been finalised in January 2019 and each region was preparing a Fuel Management Plan to replace the regional fire management plans. The KPI was not amended and so is unchanged for this reporting period.

STATUS

Prior to 2016-17, data were not readily available on the outcomes of prescribed burns. Of the 635 prescriptions approved within the Prescribed Burn System between 2016-2021, 319 had their objectives reported against (Figure 10).

The number of prescribed burns undertaken since the mid-term performance review that have met their objective has increased, particularly in Swan Region. Of the prescribed burns that had been reported on, 64 per cent fully achieved their objective while 26 per cent only partially achieved the objective and 10 per cent did not meet the objective. Not all burns had their success criteria reported on.

The department has largely completed Fuel Management Plans that provide a risk-based approach to prescribed burning for all three regions within the FMP area.

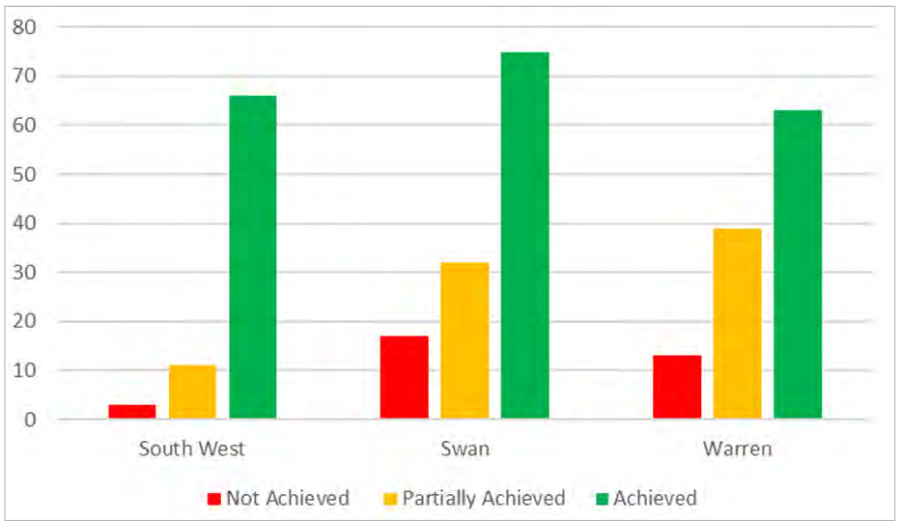


Figure 10. Achievement of post-burn success criteria 2016-2017 to 2020-2021 burn seasons (n=319).

RATING

Not all burn prescriptions are reported on as there are more burn prescriptions planned than can practically be achieved each year. This provides flexibility in the burn program to accommodate environmental and other factors.

The number of incomplete burns that required further ignition also contributes to the proportion of burn prescriptions meeting their objectives. Changing weather conditions, variation in fuel loads across the prescribed area and resourcing availability influence the ability to complete the entire prescription within the timeframe stipulated.

There are a number of prescriptions consisting of several management cells within the overall burn planning area. These cells can be burnt at various times under the prescription, including in subsequent years and may not be individually reported on.

Several large prescribed burns are implemented through the incremental treatment of smaller, internal cells over a number of years. These burns are generally carried into the following year's burn program and are not fully completed or closed for reporting purposes within a reporting period (financial year).

MANAGEMENT RESPONSE FOR THIS FMP

Through the Fire Reform Project, the department has commenced the development of a further iteration of the online electronic prescribed burn system for developing, approving, monitoring and reporting on prescribed burn programs, objectives and success criteria.

CONSIDERATIONS FOR THE NEXT FMP

The department will seek to:

- Finalise the regional Fuel Management Plans to guide risk-based decision making and operations.
- Complete and implement the Fire Reform Project to facilitate improved reporting on success criteria and burn achievements on an annual basis.
- Aim to establish guidelines surrounding the length of time a burn is allowed to remain open.
- Aim to incorporate reporting on prescriptions that accommodate individual management cells within a larger burn area.

2.8 KPI 8 Weeds, pests or disease pathogens

2.8.1 Weeds

KPI	Performance target	Year	Achievement	C
8.1	(Distribution or density of priority weeds) as defined in the relevant regional nature conservation plans	2017	↗	M
		2021	↘	M

BACKGROUND

Weeds are widespread across the FMP area and can pose a serious threat to natural ecosystems and the native species they support. The impacts of weeds within the FMP area vary depending on the type of weed and the location. A prioritisation process is undertaken by the department to identify priority weeds for management and eradication. The department focusses on reducing the impacts on key assets and values as well as preventing new incursions and eradicating new infestations.

In the mid-term performance review the department reported on the area and density of weeds for 38 sites within the FMP area where management activities had been undertaken. A total of 43 weed species were considered with some sites having multiple weed species present. At sites where consistent, long-term management actions for weeds had been applied, the condition of key conservation values under pressure from weeds had generally improved. For sites where weed control was limited or inconsistent, the density of weeds increased.

FORESTCHECK results indicated that weed numbers in State forest are generally low. Monitoring found that weeds increased immediately following a disturbance activity such as harvesting or prescribed burning, before decreasing as the native vegetation recovered.

The CPC acknowledged the positive trend for the effective management of priority weeds and noted that limited information had been provided on the prioritisation of weed management. The department continued to review and apply its weed prioritisation process, including the adoption of the Regional Priority Weeds and Locations process. The CPC was advised in April 2020 that a standard methodology for monitoring weeds was in place with the Weed Occurrence and Treatment application ('Weed App') deployed to all regions to standardise the collection of occurrence and treatment data for priority weeds.

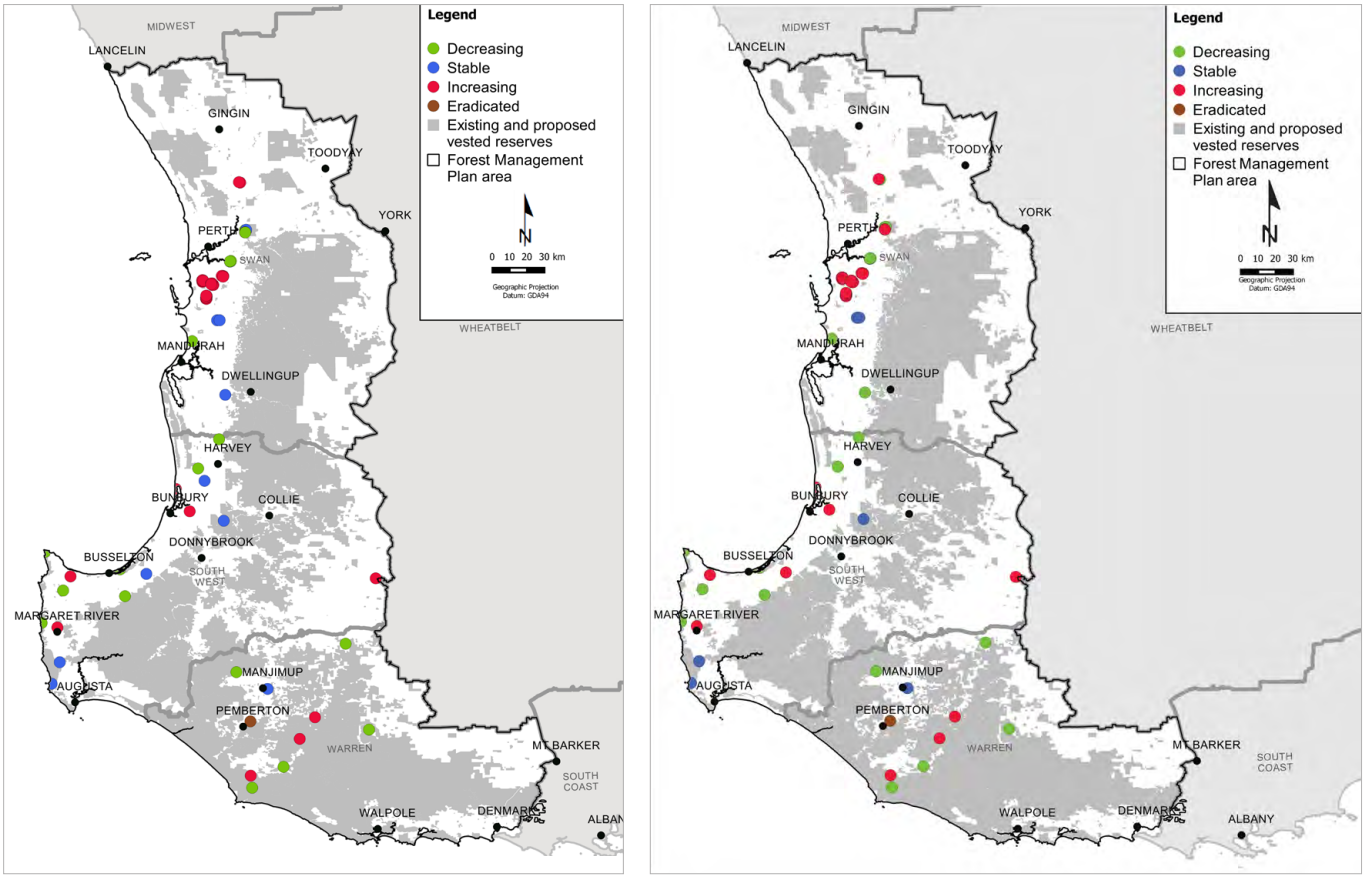
STATUS

In the three departments three regions in the FMP area, 152 species have been identified as priority weeds. Some of these species are common across the three regions while others are specific to one region and not a priority or issue in the others.

The trends in area and density of weeds for 38 sites reported in 2017 in the mid-term performance review were compared with the trends for the same sites in 2021 (Figure 11). More sites with an increasing trend in area and density of weeds were recorded in 2021 than 2017.

In Swan Region, trends for different weeds were reported separately at each of the 11 sites. For these sites, it was not possible to determine an overall trend in weed density and area.

Of note, narrow-leaved cottonbush (*Gomphocarpus fruticosus*) has been eradicated from one site in Warren Region and *Impatiens sodenii* is recorded as potentially eradicated from another site in Warren Region.



a) Area trend b) Density trend

Figure 11. Trend in a) area occupied by weeds on monitoring sites impacted by weeds b) density of weeds on these sites, between 2017 and 2021.

The condition of key conservation values for 32 sites was assessed based on information available and provided by the department's regional and district staff (Figure 12 and Table 9). In 2017, nine per cent of values had their condition assessed as declining, 28 per cent were stable and 63 per cent were improving. In 2021, 32 per cent had their condition assessed as declining, 34 per cent were stable and 34 per cent were improving.

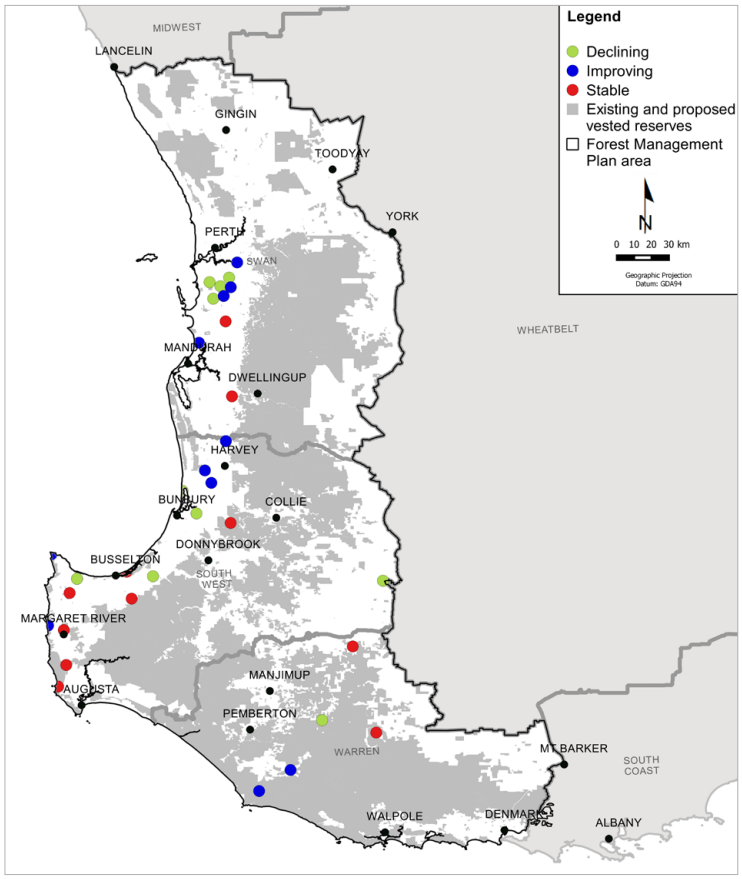


Figure 12. Trend in condition of conservation values on monitoring sites impacted by weeds, between 2017 and 2021.

	Swan		South West		Warren		Total	
Trend	2017	2021	2017	2021	2017	2021	2017	2021
Declining	2	4	1	5	-	1	3	10
Stable	-	2	7	7	2	2	9	11
Improving	8	4	9	5	3	2	20	11

Table 9. Trend in condition of conservation values on monitoring sites impacted by weeds.

RATING

The location of priority weed species, density and populations is generally well known and reported locally, although methods of measurement, data capture, and storage of weed population information are not always consistent across the FMP area.

Limited resources and experience within the department to undertake strategic weed management has contributed to an increase in weed species, abundance and locations. At times the potential impact and/or feasibility of control, and hence the priority of some weeds was unknown, resulting in greater impacts from weed infestations on the surrounding environment.

Since the mid-term performance review, external funding for weed management ceased at four sites in Swan Region and the trends in area and density for all species at these sites changed from a mixture of decreasing, stable and increasing in 2017 to all sites showing an increasing trend in 2021. At some other sites, increased vegetation growth from revegetation projects combined with weed control has seen the trend in weed area and density decrease.

MANAGEMENT RESPONSE FOR THIS FMP

The department has addressed the commitment to review the weed prioritisation process, with the identification of priority weeds and sites. The weed prioritisation process has rated over 1000 weed species allowing strategic and local planning to be undertaken to inform management programs to control the spread and maintain or reduce the distribution of weeds.

Within available resources, priority weeds are identified and addressed using a strategic and coordinated approach. In some areas, the application of this prioritisation process allowed weed control actions to be expanded to adjacent areas where the same weed was located.

The department has responded to infestations of weeds in areas of higher conservation value and implemented subsequent monitoring to allow reporting on the extent and changes in the weed populations and density within the FMP area.

The application and implementation of the Weed App for reporting on weed occurrence and treatment information continues to improve the department's response to priority weeds. In addition, the department reviewed, updated and strengthened training for its staff in weed identification, management and monitoring. Full implementation was delayed by the COVID-19 pandemic but is now underway.

CONSIDERATIONS FOR THE NEXT FMP

The department will seek to increase resources for implementation of the next FMP to:

- address weeds threatening identified high priority areas and values.
- continue to refine and implement consistent, standardised data collection, monitoring and reporting methodologies across the regions to enable management effectiveness to be evaluated.
- develop a contemporary weed management activities database which will incorporate and build on the weed prioritisation process.
- continue to undertake regular reviews of the weed prioritisation process within regions to identify priority weeds.
- continue to implement and improve the 'Weed App' for recording weed infestations and control measures.
- provide support and training associated with the 'Weed App' to improve the effectiveness of weed management programs.
- maintain weed science capability.

[9] FeralScan is a community resource to help people monitor, map and manage pest animals.

2.8.2 Pests

KPI	Performance target	Year	Achievement	C
8.2	Distribution or density of priority pests as defined in in the relevant regional nature conservation plans.	2017	—	L
		2021	↗	M

BACKGROUND

Pest animals can cause significant damage to the natural environment and can have a detrimental impact on the values of the south-west forests that the department is protecting. Control of pest animals is conducted using broadscale baiting under the department's Western Shield program. Additional methods such as approved recreational hunting, trapping and shooting programs are also employed to manage pest animals. Remote camera traps are deployed to monitor foxes and feral cats as well as the presence of native species.

The department provided an overview of the control programs for pest animal control in the mid-term performance review, noting that the distribution and density of pest animal species can be difficult to determine as they are highly mobile and their populations fluctuate seasonally. Pest animals that are targeted by control programs in the FMP area include pigs, goats, foxes, feral cats and deer. Each species has a different priority depending on the location and the level of impact. A persistent threat is posed by feral cats and foxes across the entire FMP area.

The CPC recommended that the department review the measurement protocols and prioritisation process for pests. The department provided further information to the CPC in April 2020 advising the suitability of applying a similar approach for pest animals that is used for weed prioritisation was being investigated. The department also noted that monitoring under Western Shield had improved and collation of data on priority pest animals from regions had begun and would inform a review of the measurement protocol.

Additional information on the distribution and density of feral animals was provided to the CPC in March 2021, based on information from FeralScan[9] and collected by district staff. The department advised that it will collaborate with the Australian Bureau of Agricultural and Resource Economics and Sciences, and other States and Territories on the National Pest and Weed Distribution Project.

STATUS

Foxes and feral cats are the most significant pest animals in the FMP area due to their impact on native fauna through predation. The Western Shield program delivers landscape control of these pest species through aerial and ground baiting over approximately 86 per cent of the FMP area.

Western Shield continues to deliver against targets set out in the *Western Shield Plan 2017-2026* (DPaW 2017). Feral cat management and the expansion of baited areas have been achieved, supported by a coordinated effort with external stakeholders and adjoining land managers.

Feral pigs can increase the spread of diseases including dieback as well as physical damage to the environment and the soil and vegetation, particularly in important riparian zones. Feral pigs are distributed across the majority of the forest ecosystems within the FMP area although the densities vary (Figure 13). The department continues to undertake and deliver feral pig control activities in areas of high conservation value.

The distribution of deer and goats in the FMP area is generally considered low, as is density, based on information in FeralScan and local knowledge.

RATING

The majority of carnivore pest management is coordinated and undertaken by the Western Shield program through partnerships and working closely with other landowners, stakeholders and proponents. The program has been expanded to include more areas of strategic feral cat baiting to achieve conservation outcomes.

Pest animal control effort for targeted species varied for each region, based on the risk posed to values and reserves. The success was dependent on the type of control used, resources available, seasonal variation and control effort over a given timeframe.

MANAGEMENT RESPONSE FOR THIS FMP

Western Shield has continued to efficiently bait 86 per cent of the FMP area while also being implemented statewide. Feral cat and fox activity increases following disturbances such as timber harvesting, bushfire and prescribed fire. Additional baiting has occurred following disturbance activities, including the use of Eradicat® feral cat baits. This work has been made possible with financial and on ground support through partnerships. Collaboration with recreational hunting groups has also assisted in targeting pest animal species.

Standard monitoring has been developed under the Western Shield program to determine the effectiveness of control efforts. Since 2020, a monitoring framework has been established across 21 sites, with the first set of results expected in 2023.

Preparation of regional conservation plans is underway with completion expected in 2022. The plans will identify prioritised conservation actions to be delivered by regional staff, with support from other sections of the department, to address key threats including pest animals.

CONSIDERATIONS FOR THE NEXT FMP

The department will seek to increase resources for implementation of the next FMP to:

- enhance the Western Shield program to deliver and increase aerial fox baiting within the FMP area and integrate feral cat baiting in suitable areas to reduce predation pressure caused by feral cats and foxes on threatened and priority species of fauna.
- enhance the department's pest animal science capability.
- introduce supplementary fox and feral cat baiting following disturbance operations.
- increase effort in managing feral pigs, particularly in areas of high ecological value.
- increase effort in managing feral deer and investigate opportunities to enhance rabbit control.
- continue to develop partnerships and programs with recreational hunting groups to augment the resources available for targeted pest animal control.

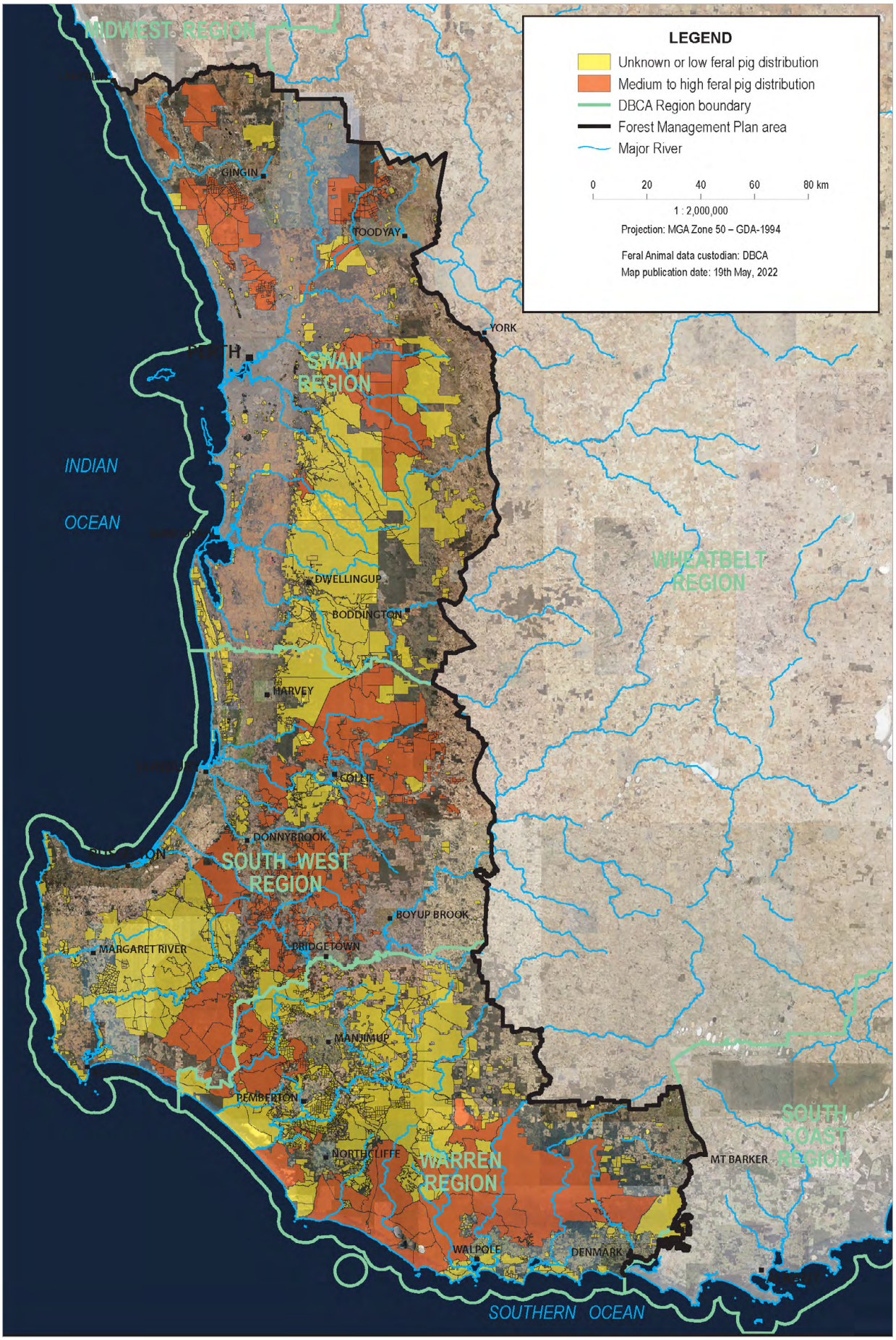


Figure 13. Density and distribution of feral pigs across the conservation estate within the FMP area in 2020.

2.8.3 Diseases

KPI	Performance target	Year	Achievement	C
8.3	(Distribution or density of priority diseases) as defined in the relevant regional nature conservation plans.	2017	↘	M
		2021	↘	M
8.4a	No planned operations undertaken without an approved hygiene management plan – timber harvesting.	2017	↘	H
		2021	↗	H
8.4b	No planned operations undertaken without an approved hygiene management plan – other disturbance activities.	2017	↗	M
		2021	—	M
8.4c	Less than three per cent of uninfested protectable area infested as a result of management activities – timber harvesting.	2017	↘	H
		2021	↘	L
8.4d	Less than three per cent of uninfested protectable area infested as a result of management activities – other disturbance activities.	2017	—	L
		2021	—	L

BACKGROUND

Phytophthora dieback is caused by the plant pathogen, *Phytophthora cinnamomi*, which kills susceptible plants, such as banksias, jarrah and grass trees, by attacking their root systems. It is the priority disease managed by the department in the FMP area.

Dieback is considered ineradicable and spreads autonomously through root-to-root contact, surface and subsurface movement of water in the landscape, and physically due to animals and humans moving infested soils. Disturbance and movement of infested soils by humans has the greatest dieback spread potential. It is expected that dieback will continue to spread and eventually become established in all niches of the environment that support its reproduction.

To reduce the rate of spread of *Phytophthora* dieback, the department has developed dieback management procedures, manuals and supporting tools including:

- mapping and interpretation of department-managed lands.
- requiring dieback management plans[10] (DMP) for disturbance operations.
- providing training in dieback awareness and basic hygiene for staff and contractors.
- controlling access in disease risk areas and priority protection areas.

In the mid-term performance review, it was reported that 28 per cent of department-managed land was comprehensively mapped for occurrence of *Phytophthora* dieback. Of the area mapped, 31 per cent was infested. All disturbance activities in native forest had an approved DMP and it was identified that the most significant factor causing the spread of the disease was ineffective road closures resulting in unauthorised access to disease risk areas.

The CPC noted that there were reduced rates of spread of the disease and recommended that the department undertake and report information annually on the compliance of operations with DMPs, and to also undertake an investigation to improve the effectiveness of road closures.

[10] DMPs in this report refer to Dieback Management Plans which replaced Hygiene Management Plans (HMPs) in October 2017 and for FPC in October 2020 and non-standard dieback management documentation sometimes used by external proponents.

STATUS

8.3 (Distribution or density of priority diseases) as defined in the relevant regional nature conservation plans

By the end of 2020, the department had collected information about the dieback occurrence on a further 10 per cent of department-managed land within the FMP area, bringing the total to 38 per cent, or almost one million hectares (Figure 14). Across department-managed lands in the FMP area with dieback occurrence information, 37 per cent is infested. Of the 361,000 hectares of infested area, 13 per cent is within Disease Risk Areas and two per cent is in Project Dieback Priority Protection Areas[11].

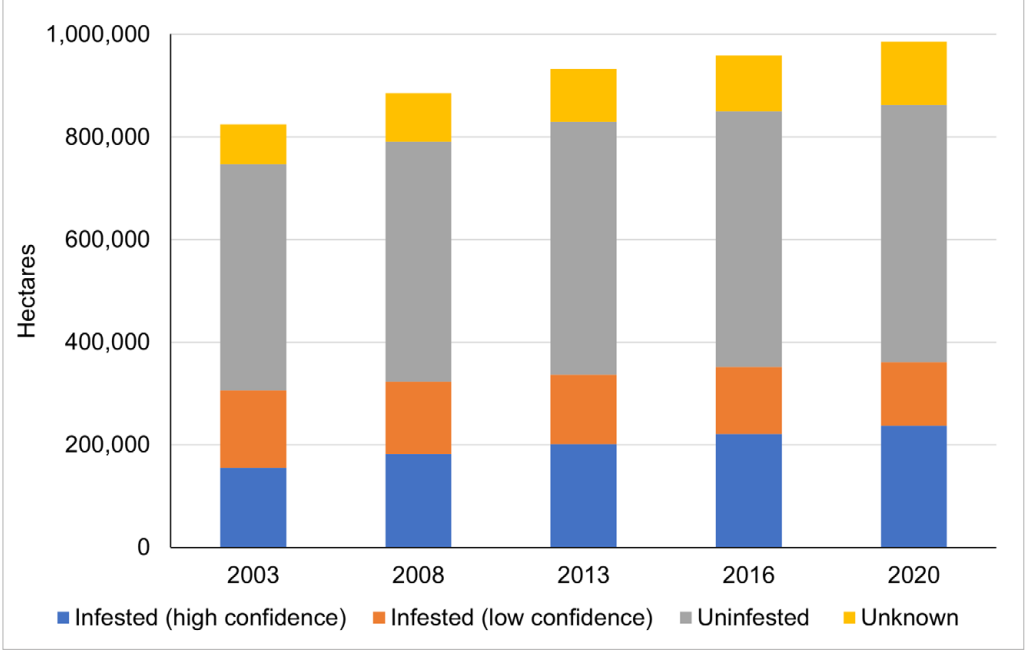


Figure 14. The number of hectares within the FMP area that are managed by the department for which there was dieback occurrence information. The categories of information are: infested (high confidence) which was collected through comprehensive dieback occurrence assessment by interpreters; infested (low confidence) collected through remote or inferred methods of dieback occurrence assessment; uninfested as assessed by an interpreter, and; unknown which refers to areas that are uninterpretable.

8.4a,b No planned operations undertaken without an approved[12] hygiene management plan – a) timber harvesting and b) other disturbance activities

Based on an assessment of over 400 operations between July 2018 and October 2021, the performance target that all operations have an approved DMP was not met. In native forest, DMPs were available for all timber harvesting operations by FPC and for 87 per cent of the department's operations (Table 10). For operations in plantations and other operations by FPC, 24 per cent had an approved DMP. For operations by external proponents, 71 per cent had an approved DMP.

Operation Type	Operations with a DMP (%)
Native forest timber harvesting - FPC	100
Department operations	87
Plantation operations	24
External proponent operations	71

Table 10. Percentage of timber harvesting and other operations that had a DMP.

[11] Priority Protection Areas (PPAs) representing the most significant examples of ecosystems that are vulnerable to dieback within the south-west of Western Australia are identified in the State *Phytophthora* Dieback Management and Investment Framework. PPAs cover almost 1.2 million hectares of biodiverse ecosystems and 75 per cent of them are on CALM Act land.

[12] (Approved' or 'compliant' disease management plans must meet all of the following criteria: i) a completed dieback risk assessment; ii) risk is not underestimated; and iii) it is based on dieback occurrence information appropriate to dieback risk.

In the mid-term performance review only 29 per cent of the 34 operations assessed had a formal DMP. There has been an increase to 87 per cent of all high or moderate risk operations with a DMP. For operations with no DMPs, FPC plantations made up over 50 per cent as these areas have a lower hygiene risk; department roads and tracks 15 per cent and department fence-line, fire and recreation sites had less than 10 per cent each.

8.4c Less than three per cent of uninfested protectable area infested as a result of management activities – timber harvesting

This performance target has not been assessed since the mid-term performance review primarily due to a change in focus to the compliance of DMPs and the ability of proponents to undertake the activities detailed in an operation's approval conditions. In 2020-21, 101 dieback management tactics were assessed and 60 per cent were found compliant. Particular attention was paid to clean-on-entry (COE) points and road closures. The level of compliance with COEs increased in 2021-22 to 72 per cent being compliant. Between July 2020 and October 2021, 80 per cent of assessed road closures met the required standard.

8.4d Less than three per cent of uninfested protectable area infested as a result of management activities – other disturbance activities

Other disturbance activities were not field monitored since the mid-term performance review as their suitability and appropriateness has been able to be assessed through the DAS. Where it was identified an action could have a detrimental impact on the natural environment through spreading of disease, a different management response was recommended prior to the disturbance being approved.

RATING

Distribution of *Phytophthora* dieback

The department has continued to increase knowledge of dieback occurrence in the FMP area. The information on the distribution of dieback on lands managed by the department in the FMP area has been collected and collated primarily as a part of a process to mitigate the dieback risk of timber harvesting activities and therefore has occurred primarily in State forest.

Effectiveness of dieback management planning

Of all operations approved between July 2018 to October 2021, 59 per cent were compliant with DMPs. DMPs for FPC native forest harvesting had the highest compliance averaging 91 per cent, the department averaged 32 per cent and compliance with DMPs was lowest for non-FPC external proponents and FPC plantations/other at 16 per cent and 15 per cent, respectively.

Non-compliance across all operations was associated with a failure to undertake dieback risk assessments of operations and risk being underestimated. The development of DMPs with no, or inadequate, dieback occurrence information also occurred.

Significant contributors to the high proportion of DMPs with no, or inadequate, dieback occurrence information include: the cost of dieback interpretation; and a shortage of suitably experienced dieback interpreters available for dieback mapping for either short or long periods.

The shortage of dieback interpreters remains an issue, posing significant challenges for dieback management and implementation of standards. The department has not been able to recruit the number of interpreters required to deliver the output expected. This has contributed to the low levels of development and implementation of compliant DMPs.

MANAGEMENT RESPONSE FOR THIS FMP

The increase in operations with DMPs can be attributed to the introduction of a standardised procedure and requirement for DMPs for all operations in late 2017. Prior to this DMPs were developed primarily for native forest harvesting operations only.

Since 2014, training in dieback awareness, risk assessment and management planning has been delivered to over 1800 department staff, FPC, and external proponents. Over half of this training has occurred since 2017 to support the implementation of new procedures. In late 2020, an online version of the department's Green Card dieback course was launched and has consequently increased the reach of this training.

While Green Card training has resulted in greater awareness about the requirement for DMPs, compliance with the DMPs developed is low because of the cost of interpretation and/or shortage of interpreters to undertake the work.

The Enhanced Prescribed Burning Program also facilitated increased mapping of Phytophthora dieback, which underpins the development of DMPs for prescribed burn activities. It will take some time to determine the effectiveness of these disease management improvements in reducing dieback spread.

As reported to the CPC in 2021, the department continues to work with Main Roads Western Australia towards the development of new technology to 'disinfect' dieback infested gravel using metham sodium.

Other diseases

The department is on alert for the detection of Myrtle rust (*Austropuccinia psidii*) and the Polyphagous Shothole Borer (*Euwallacea fornicates*) (PSHB) in the FMP area. Myrtle rust has not been detected in the FMP area to date. PSHB was first detected in Western Australia in 2021 but is currently restricted to parts of the Perth metropolitan area.

This is the first incursion of PSHB to Australia. The insect has a symbiotic relationship with a fungus from the genus *Fusarium* which can cause disease and death in a wide range of both native and exotic species. The impact that PSHB could have on the natural environment if uncontainable, is currently unknown.

CONSIDERATIONS FOR THE NEXT FMP

The department will seek to increase resources for implementation of the next FMP to:

- develop capacity to improve hygiene management, including a strategic approach towards dieback management and interpreter development.
- continue monitoring infested sites to better understand indirect dieback impacts over time in different forest ecosystems and in the context of a changing climate.
- resource wider operational application of existing technologies including phosphite; metham sodium treated gravel, and containment and eradication techniques.
- continue research into methods to control the spread and ameliorate impacts of dieback in infested landscapes.
- maintain a plant health science capability.
- further investigate operationalising the use of aerial remote sensing methods to supplement on-ground dieback assessments.
- provide ongoing contributions to surveillance efforts for Myrtle rust and determine appropriate response options for Myrtle rust and PSHB.
- work collaboratively with FPC and other proponents to improve dieback management in operational activities.

2.9 KPI 9 Level of soil damage resulting from timber harvesting

KPI	Performance target	Year	Achievement	C
9	Soil damage not to exceed prescribed maximum levels for 95 per cent of harvest cells surveyed, except where the prescribed levels cannot be achieved with the application of good harvest practices.	2017	—	H
		2021	—	H

BACKGROUND

Soil disturbance, primarily from compaction and soil layer mixing, is a consequence of approved timber harvesting operations. Well-established principles and practices to minimise soil disturbance, outlined in the department's manuals and practices, are required to be adhered to for harvesting operations undertaken in the FMP area by proponents, including contractors.

Soil surveys and monitoring of the movement and activities of heavy vehicles is undertaken by the department to ensure compliance with allowable limits prescribed for moderate, severe and very severe soil disturbance. The FPC undertakes monitoring to ensure operations are occurring within allowable limits and is responsible for training proponents in soil management requirements.

For the mid-term performance review, the department reported that the majority of operations were conducted within prescribed maximum levels of soil damage. Where soil disturbance was in excess of prescribed levels, a Works Improvement Notice requiring remedial action was issued to the proponent and followed up to ensure remediation occurred.

The CPC acknowledged the commitment of the department and the FPC to refine and improve practices.

STATUS

A revised method to undertake soil surveys and monitoring was implemented during 2015-2021. The new method focusses on surveying disturbed areas within a harvesting cell and has generated a comprehensive dataset. Prior to 2015, a transect method was used that resulted in a less reliable survey result as not all extraction tracks were surveyed. There was a transition phase in 2014 where the previous survey method was phased out.

Each soil survey has two allowable limits, where moderate disturbance must be eight per cent or less and severe disturbance two per cent or less. Moderate disturbance is generally from vehicles moving through the harvesting area, while severe disturbance is where the subsoil is exposed to a depth greater than 50 cm and can occur from rutting, pushing of rocks or pulling of tree stumps. It is possible for a single survey to be within the allowable limits of moderate disturbance but exceed severe disturbance limits or vice versa.

From 2015-2021, 199 soil surveys were conducted in the FMP area (Table 11). Of these, five were in karri forest and 194 were in jarrah forest. No surveys were undertaken in pine plantations or mine site rehabilitation areas. The number of surveys undertaken depended on where the harvesting operations were occurring during the FMP period and as such were not undertaken evenly across all regions and districts.

	2014	2015	2016	2017	2018	2019	2020	2021
Number of surveys conducted	54	42	32	25	18	16	39	27
Number (and %) of surveys that exceeded allowable limits of moderate and/or severe soil disturbance	13	13	15	3	2	5	9	3
	(24)	(31)	(44)	(12)	(11)	(31)	(23)	(11)
Percentage of surveys within allowable limits for moderate soil disturbance	80	76	69	92	95	75	90	100
Percentage of surveys within allowable limits for severe soil disturbance	87	83	56	92	89	81	77	89

Table 11. Summary of results from monitoring of soil disturbance.

The performance target was exceeded each year for the period 2014-2021, although the majority of operations were conducted within allowable limits of soil damage.

The factors contributing to the allowable limits being exceeded were the machinery configuration and where best practice management actions, outlined in the *Manual of procedures for the management of soils associated with timber harvesting in native forests* (DPaW 2015), were not followed. The type of operation and the product that was removed from a coupe were not significant contributors to the exceedance of the allowable limits.

The soil trafficability index (TI_{SDI}) guides the risk period in which the operation will be occurring with dry soils representing a low risk, moving into a medium risk period during wet months and a high risk usually occurring over the winter/spring period. Soil disturbance exceeding the prescribed levels occurred in all seasons, with a slight increase in the winter months.

Compliance with soil disturbance limits improved significantly following training for proponents and FPC staff, reducing from 44 per cent exceeding the allowable limits in 2016, to 12 per cent in 2017, and 11 per cent in 2018 and 2021.

RATING

- The percentage of disturbance activities that exceeded the allowable limits decreased during the FMP period. The improvement was due to training of proponents and improvements implemented by the FPC in planning the extraction track layout.
- The low percentage of soil surveys within the allowable limits in 2016 is due in part to the FPC trialling variations to the harvesting techniques to determine best practice and conducting intensive monitoring with the expectation that a large number of surveys would exceed the allowable limits.
- The number of operations increased during the FMP period, resulting in an increase in the amount of heavy vehicle movement and disturbance. The limits in place for soil disturbance are suitable to guide the operations, and if best practice is followed the harvesting operation will not exceed the allowable limits.

MANAGEMENT RESPONSE FOR THIS FMP

A new procedure for formal soil disturbance monitoring was approved and implemented in 2015 and updated in 2020, improving the robustness of results and allowing consideration of whether an approved disturbance was well-managed. The FPC conducted soil management training for its contractors and staff during this FMP period and the number of soil surveys exceeding the allowable limits showed a decline immediately following this training.

Working with the FPC, the department has clarified best practice management actions to minimise soil disturbance in native forest harvesting areas. To reduce the amount of disturbance that is created from forest operations, the department recommends that proponents utilise previously disturbed areas (such as existing extraction tracks), and address and repair instances of severe disturbance.

A systematic approach to monitoring, assessing, and mapping existing extraction tracks is currently not in place. This has led to the creation of new extraction tracks in the field when the existing tracks were unsuitable or not incorporated into the planning process. Further work is being undertaken to ensure improvement in planning disturbance operations, including machine configuration and extraction track assessment and layout.

Use of technology, such as terrain modelling, is being investigated to assist in broader scale capture of data to enable greater oversight of operations across multiple cells, as opposed to monitoring an individual cell in a specific area.

CONSIDERATIONS FOR THE NEXT FMP

While large scale, commercial timber harvesting will no longer occur in the FMP area from 2024, minimising soil damage will remain an important element for ecological thinning operations. The department will seek to:

- ensure that survey results are representative of disturbance operations in different forest types.
- review manuals, guidelines and procedures and investigate technology solutions to cover different operating environments.
- limit disturbance activities to when the soil trafficability index (TI_{SDI}) is within low to medium risk periods and ensure that operations occur on previously disturbed extraction tracks, where relevant.

2.10 KPI 10 Stream condition and groundwater level

KPI	Performance target	Year	Achievement				C
10.1	No gauging stations with annual flow weighted mean salinity that is not fresh as a result of management activities.	2017				—	H
		2021				—	H
10.2	No sites with a decline in streamflow as a result of management activities.	2017				—	H
		2021				—	H
10.3	No decline in groundwater level as a result of management activities. No rise in groundwater level to the extent that it could lead to annual stream salinity not remaining fresh, as a result of management activities.	2017				—	H
		2021				—	H

BACKGROUND

The protection of the ecological integrity and water quality of groundwater, streams and wetlands and their associated vegetation is a goal of FMP 2014-2023. To assess stream condition and groundwater levels, data from streamflow gauging stations, conductivity probes and groundwater monitoring bores provide information about the hydrological processes occurring within catchments.

For the mid-term performance review, the performance targets were reported as achieved and stable. Streams in fully forested catchments remained fresh although declining streamflow and groundwater levels were identified. This decline was attributed to the continued drying trend across the FMP area and was not considered to be the result of management activities.

The CPC noted the impacts of climate change on stream condition and groundwater recharge. The potential benefits to stream condition from silvicultural treatments was acknowledged and the CPC recommended that the department continue to investigate opportunities to improve stream condition through cost-effective management activities.

STATUS

All performance targets for this KPI have been achieved. Results of 33 sites within the FMP area were used to inform the assessment of streamflow trends, six sites were used for the salinity analysis and bores within three sub-catchments, Bates, Del Park and Yarragil Brook, were assessed (Table 12).

The target for streams within fully forested catchments to remain fresh was achieved. Average annual flow weighted salinity increased in 63 per cent of the sub-catchments examined, declined for 25 per cent and was stable for the remainder. The increase in salinity corresponds with significant reductions in streamflow over the reporting period (2017-2021). Despite the increases in salinity, there were no sub-catchments which changed from fresh to brackish conditions.

Performance entity	General trend	Comment
Stream salinity	Steady	Stream salinity within fully forested catchments remains steady although average annual salinity increased for over 50 per cent of monitored sub-catchments.
Streamflow	Decreasing	All catchments, except one in Warren Region (Carey Brook) recorded reductions in annual streamflow.
Groundwater level	Decreasing	The majority of bores recorded a trend of declining groundwater level, although levels are stabilising at a number of bores.

Table 12. Summary of stream condition and groundwater level.

From the 33 streamflow sites analysed, 32 show a decrease in annual average streamflow over 2014-2020 compared to the previous FMP period, 2004-2013. One site located in Warren region (Carey Brook) did not show a decrease in annual average streamflow (Figure 15) but demonstrated perennial flow. The trend towards declining streamflow for this site in the longer term can be attributed to changing climate.

Groundwater data was available for three sub-catchments located within Swan Region. The long-term trend shows declining groundwater levels in all sub-catchments. However, some stabilisation/recovery in groundwater levels was observed at some monitoring sites within two of the sub-catchments.

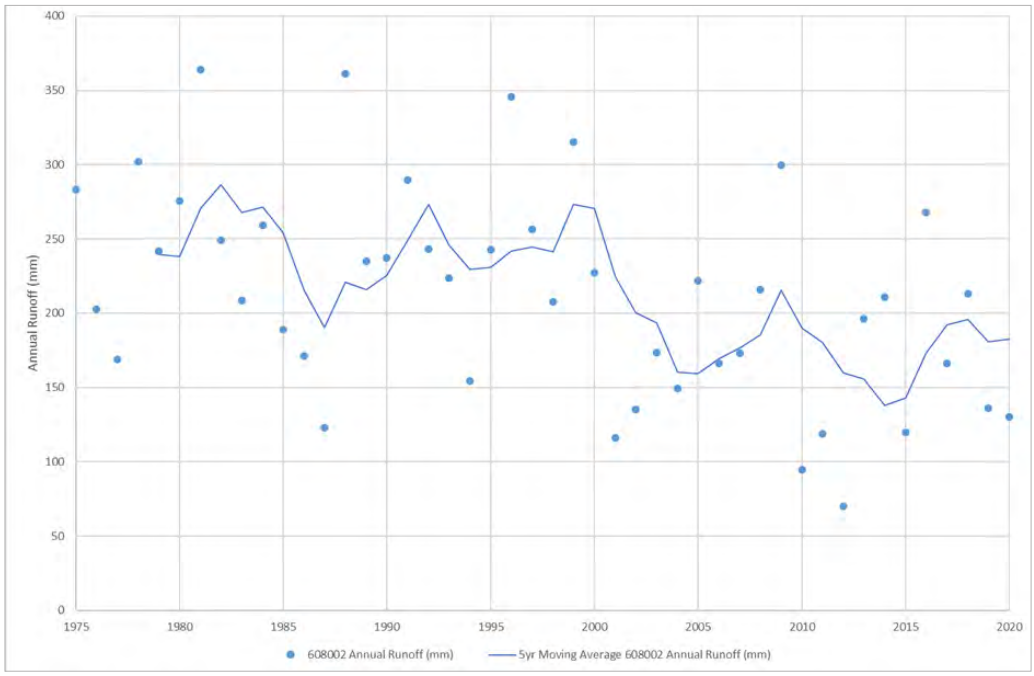


Figure 15. Achievement of post-burn success criteria 2016-2017 to 2020-2021 burn seasons (n=319).

RATING

There is a documented reduction in recorded rainfall over south-west Western Australia since 1975 (CSIRO 2009). Other studies have shown the impact of this change in climate on surface water yields. This underlying trend makes it difficult to determine what impacts, if any, management activities within forested catchments may have on salinity, streamflow and groundwater levels.

The changing climate has had a significant impact on the catchments in Swan Region. There has been a lag in the response within South West Region but it appears to be following a similar trajectory. Catchments in Warren Region have not been as affected to date as rainfall remains higher in this region, but some indicators suggest changes to the rainfall-runoff relationship in this area have commenced.

The decline in groundwater levels below that of streambeds has reduced the area of the catchment that is saturated. Subsequently less runoff has resulted when rainfall occurs as groundwater is recharged rather than surface runoff occurring.

Limited groundwater data was available within fully forested catchments, which reduced the ability to compare water level trends under different forest management practices. All assessed bores show a declining water level trend over the longer period, although some stabilising of groundwater levels was observed between 2017-2019 at a number of the assessed bores. This followed a particularly dry year in 2015 and levels did not return to pre-2010 levels. It was not possible to separate the impact of climate (i.e. reduced rainfall) from any impacts from management activities in the catchments. As groundwater levels have been declining over the longer term, the risk of rising groundwater causing stream salinity issues is not currently a concern.

MANAGEMENT RESPONSE FOR THIS FMP

Ecological thinning can be used to reduce moisture stress in the short and longer term by reducing the number of small trees in an area of forest. A working group has been established that is trialling ecological thinning demonstration sites, with the first commenced in Munro block near Balingup in 2021. Post-thinning hydrological monitoring to inform management of forest water balance and silviculture continued in the Yarragil sub-catchment.

CONSIDERATIONS FOR THE NEXT FMP

The scope and approach to forest management activities that improve forest health and resilience, including thinning for ecological purposes will be canvassed through the development of FMP 2024-2033.

A monitoring program will be required to enable conclusions to be drawn about the impacts of management activities on salinity, streamflow and groundwater levels.

2.11 KPI 11 Effectiveness of silviculture for water production

KPI	Performance target	Year	Achievement	C
11	1. Catchment management plans are prepared and approved for areas to be treated. 2. Compliance of treemarking, harvesting and related treatments with targets specified in the relevant guidance documents.	2017	Not applicable	H
	3. Streamflow is at least maintained, or the rate of decline is reduced as a result of treatment. No gauging stations with annual flow weighted mean salinity that is not fresh as a result of management activities.	2021	Not applicable	H

BACKGROUND

Silviculture for water production involves the implementation of silviculture treatments such as thinning, shelterwood, gaps, selective and selection cuts across areas of native forest, to maintain or enhance water supply. This provides ancillary benefits for ecosystem health and vitality. To implement silviculture for water production, in FMP 2014-2023 the development and approval of a catchment management plan was required prior to undertaking any silvicultural operations for water production.

For the mid-term performance review, the CPC noted that this KPI was not required to be measured as no forest areas had undergone any silviculture for water production. The CPC acknowledged that the reporting of this KPI for the remainder of the FMP period was dependent on economic factors that would determine its application when appropriate.

STATUS

The status of this KPI has not changed since the mid-term performance review as silviculture for water production was not applied during the period 2018-2021 and no catchment management plans were prepared.

To examine the extent to which thinning, if implemented, may increase streamflow and groundwater, or to slow the rates of forest decline, the hydrology of several headwater catchments in the jarrah forest has been monitored since the 1970s with new groundwater sensors and streamflow loggers installed in 2020 and 2021.

Monitoring has included three jarrah forest catchments in Yarragil forest block, located approximately 20 km south-east of Dwellingup. The department has evaluated the hydrological response to intensive thinning in 1983 and 2019 and associated ecosystem health benefits at Yarragil 4L (Figure 16), and compared these with two control areas, Yarragil 4X and Yarragil 6C, that were lightly thinned in 2017. Monitoring showed that the thinning in 1983 at Yarragil 4L resulted in a pause in groundwater decline and increased streamflow. It is too early to assess the impacts from the 2019 thinning at Yarragil 4L, although streamflow was observed in 2021. The trend of declining groundwater levels at Yarragil 4X and Yarragil 6C has not changed.

RATING

The rating for this KPI remains not applicable, as no operations for silviculture for water production were conducted.

It is too early to assess whether the 2019 thinning at Yarragil 4L has had an impact on streamflow given typically high interannual variability and the relatively high rainfall in 2021 in comparison to the last few decades.

MANAGEMENT RESPONSE FOR THIS FMP

Opportunities to undertake work that would implement silviculture for water production did not present during this FMP period and no management response is required.

CONSIDERATIONS FOR NEXT FMP

The department will seek to:

- continue to monitor and implement work at sites where thinning has already occurred to demonstrate long-term effects of the thinning on groundwater and streamflow levels.
- consider refurbishment of the groundwater monitoring network to maintain a robust and reliable network of bores and monitoring equipment.
- consider implementation of technology to monitor other metrics such as tree water use, leaf area and remote sensing to inform any future thinning trials.

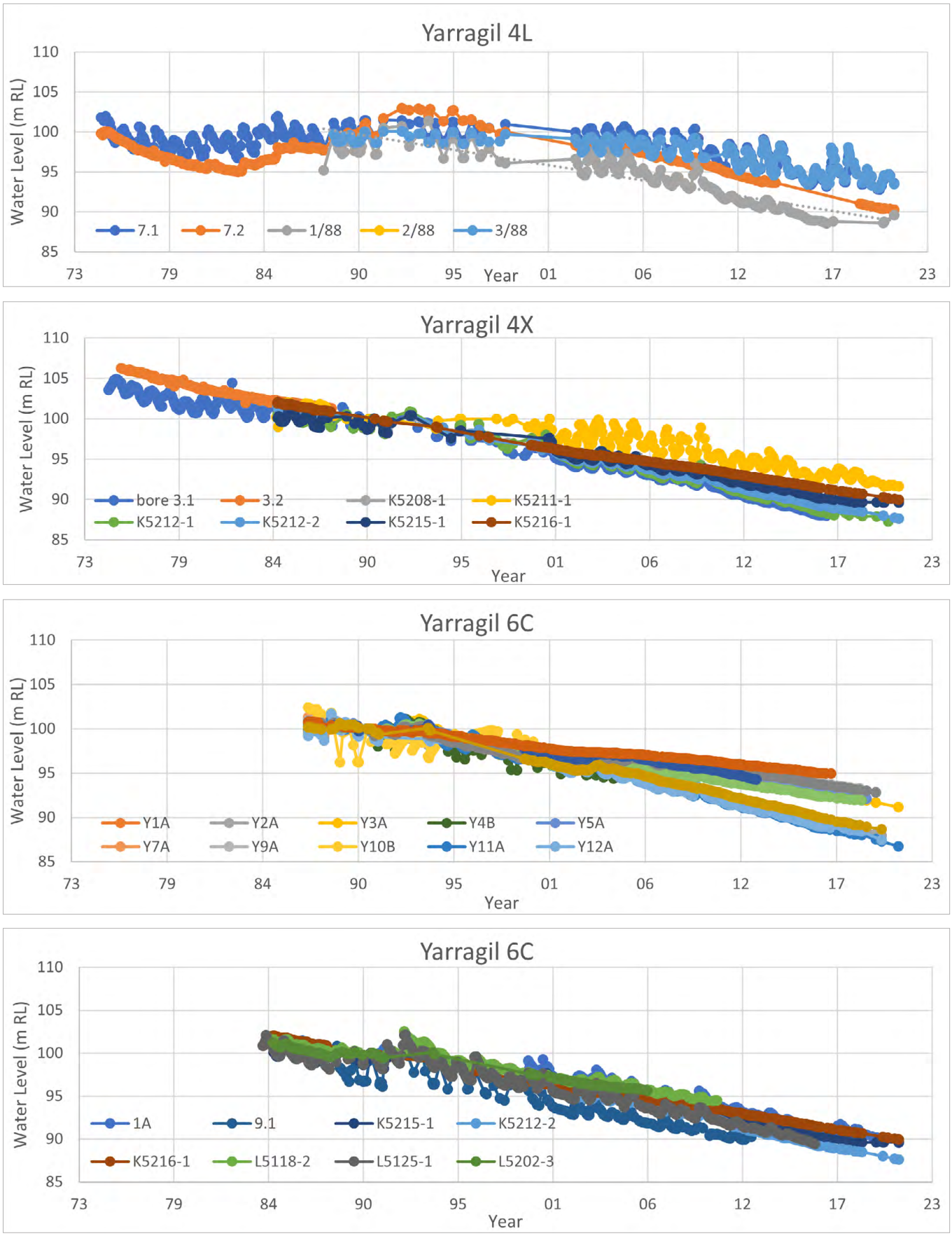


Figure 16. Groundwater levels, at Yarragil 4L, 4X, and 6C. Legends refer to individual monitoring wells. To show consistent trends levels are relative levels (RL) to a local datum for each well.

2.12 KPI 12 Increased knowledge of trends in climate

KPI	Performance target	Year	Achievement				C
12	Trend and knowledge report compiled at end of-term and used to inform reporting on achievement of KPI targets.	2017				—	H
		2021				—	H

BACKGROUND

Knowledge of the changes in climate and the range of potential impacts on native forest ecosystems and other values identified in FMP 2014-2023 is required to inform strategic planning, management activities and operational practices. It is recognised in FMP 2014-2023 that adaptive management will likely be of increasing importance to enhance forest resilience to the impacts of a drying and warming climate.

The trends in climate presented in the mid-term performance review identified that there was a decline in rainfall and an increase in average monthly temperatures across the FMP area. Data from the Bureau of Meteorology was compared for the 2011-2016 and the 1991-2010 periods. Average monthly temperatures for selected locations were found to be similar to temperatures projected for 2030.

An overview of the range of research projects conducted by the department and other research institutions related to impacts from the changing climate in the FMP area was provided in the mid-term performance review. Research that had been undertaken included the impacts of reduced streamflow on aquatic biodiversity, continued monitoring through the FORESTCHECK program and the potential for increased bushfire prevalence due to climate change.

The CPC acknowledged the ongoing impacts of a drying and warming climate and recommended that there be a continued focus on research towards understanding the implications of a drying and warming climate on ecological function, biodiversity and forest health, including consideration of treatments to improve forest resilience in a future drier and warmer climate.

STATUS

Trends in climate

The climate in the south-west of Western Australia has shifted since the 1970s, including a chronic warming of +0.15°C per decade, and a chronic reduction in early winter rainfall of 14 per cent (1975-2004 compared with the mid-1900s-1974) (Hughes 2003; Bates *et al.* 2008). Overall winter rainfall has declined between 30 to 50 per cent from 1969 to 2012 (IOCI 2012) and the 800 mm rainfall isohyet has moved westward in the north-east of the FMP area, when comparing rainfall from 1971-2018 to 1950-1970. Although this may be a component of a much longer rainfall pattern in the south-west (O'Donnell *et al.* 2021), it still has ramifications for ecosystems in the region.

The south-west has had a number of extreme events in the past decade, with the number of heatwave days each year increasing in Perth since 1950 (Cai *et al.* 2011). The number of days with temperatures greater than 40°C has almost doubled when comparing 1910-1939 to 1989-2018 (Breshears *et al.* 2021). Acute drought was experienced in 2006 and 2010, and heatwave events occurred in early 2011 and late 2019 (Cai *et al.* 2011; Ruthrof *et al.* 2018; Ruthrof *et al.* 2021). There are various hypotheses why these climatic shifts such as decreased rainfall have occurred, including multidecadal variability (Cai and Cowan 2006), changes in ocean temperature (England *et al.* 2006; Ummenhofer *et al.* 2008), landuse change (Pitman *et al.* 2004), a southern shift in storm tracks (Frederikson and Frederikson 2007) and land clearing (Andrich and Imberger 2013).

Regional climate projections suggest continued consistent reduction in winter rainfall and overall warming over the coming decades (Hope *et al.* 2015; Andrys *et al.* 2017; Ukkola *et al.* 2020). Rainfall decline will be greatest in the region's north-east (Andrys *et al.* 2017). The duration of droughts is expected to increase (Hope *et al.* 2015). In addition, large fluctuations in summer rainfall intensity are predicted (Andrys *et al.* 2017). The temperature and frequency of very hot days is expected to increase, and heatwaves will get longer and more intense. For example, Perth currently experiences 28 days per year over 35°C. Under an intermediate emissions scenario this will increase to 36 days by 2030 and 63 days by 2090 (DWER 2021).

New knowledge gained on the impact of changing climate on values identified in the FMP

Chronic trends and extreme (acute) events can exert pressure or stress on ecosystems in a variety of ways. In the north-east of the forest area, decline of vegetation cover over longer timeframes has been noted (see KPI 1; Wallace *et al.* 2009). In other areas, sudden canopy and midstorey die-off and loss of cover has occurred following extreme events such as drought / heatwaves (Matusick *et al.* 2013; Brouwers *et al.* 2013; Ruthrof *et al.* 2015; Steel *et al.* 2019).

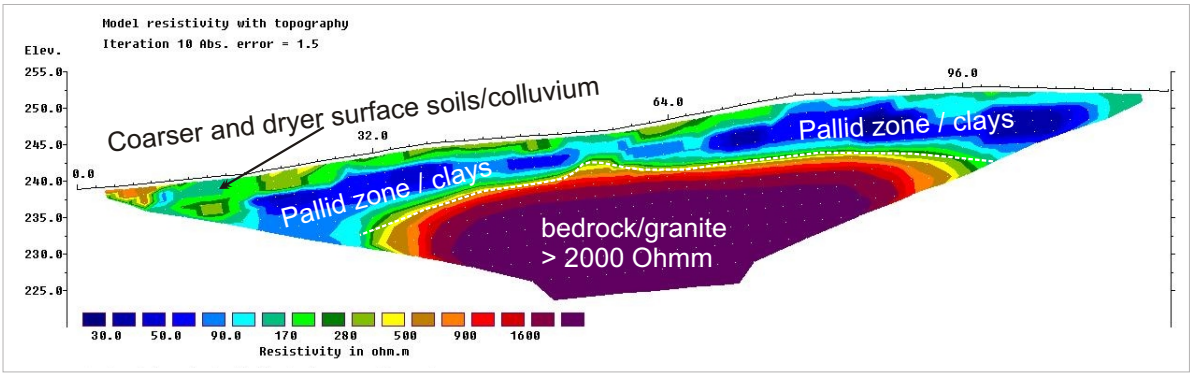
Impact of soil depth on forest canopy die-off

Given that the south-west region is predicted to become drier and hotter in the future, it is important to understand the responses of forest structure to multiple disturbance events, particularly fire and drought. The major changes in vegetation cover and health have been identified in the Northern Jarrah forest ecosystems (KPI 1) and this area is the focus of the majority of the research to date. The area of Yarloop, Western Australia impacted by bushfire in 2016, has been a major focus of several studies into the impacts and effects on the Northern Jarrah forest ecosystem.

Shallower soil depth had previously been associated with forest canopy die-off (Brouwers *et al.* 2013; Andrew *et al.* 2016), and empirical data has been collected to demonstrate the consequences at a drought vulnerable site (McGrath *et al.* in prep.). Forest overlying shallow soils (5 m to 7.5 m) experienced greater die-off than a site with deeper soils (15 m to 20 m).

Using a method known as electrical resistivity tomography (Challis 2016), soil depth was compared at drought-affected and less-drought affected sites (Figure 17). This technique shows how resistive the soil is to an electrical current. The drought affected site had shallow soils overlying a very resistive layer of dense granite bedrock (purple zone). The less drought affected site contained a deep layer of clay with a higher water holding capacity that is less vulnerable to drought-induced forest die-off.

a)



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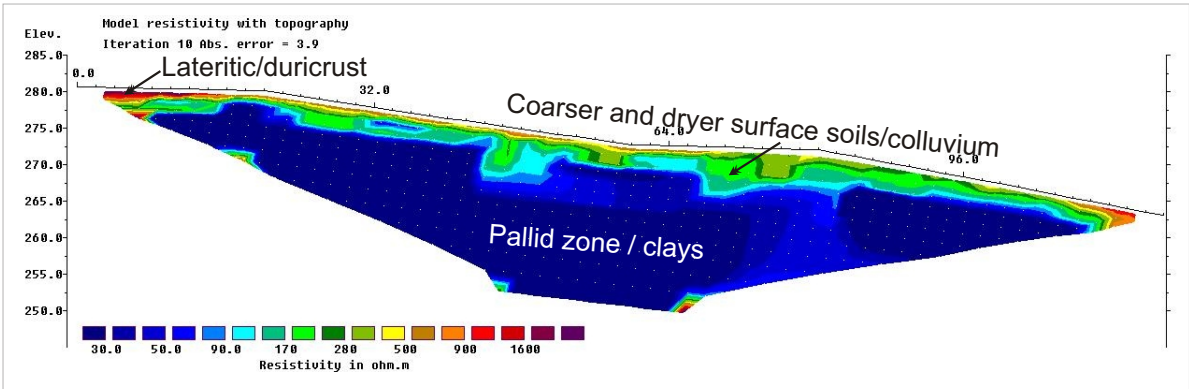


Figure 17. Resistivity across 120 m of a drought-affected site (a), and less drought-affected site (b) in the Yarloop region.

Research over the past decade into flow-on effects from drought-induced forest die-off in the Northern Jarrah forest has identified altered carbon dynamics (Walden *et al.* 2019), changed fuels and fire potentials (Ruthrof *et al.* 2016), shifts in microbial communities (Hopkins *et al.* 2018), an outbreak of a native wood boring insect (Seaton et al. 2015; 2020), and altered faunal habitat, with more open areas (Dundas *et al.* 2021). In addition, jarrah forest with a history of chronic drought stress is more prone to die-off during acute climatic events, suggesting a legacy effect of historical drought stress (Matusick *et al.* 2018).

Response of forest structure to bushfire and drought

The effects of bushfire on impact (mortality) and early response (resprouting) were examined in the Northern Jarrah forest. Forest stands that had previously been affected by drought had a higher abundance of small stems and a higher proportional resprouting height after bushfire than forest stands where drought had been less severe. That is, the combination of disturbance from drought and bushfire can promote an abundance of smaller stems, potentially creating a very different forest structure in the future (Walden *et al.* submitted). This altered forest structure was still evident three years following fire.

Research into the influence of bushfire on tree regeneration in a drought affected area indicated moderate severity bushfire resulted in higher regeneration densities over the three years since the bushfire than in areas that had a high severity bushfire (Rasmussen 2020). This means that high severity fire such as the Yarloop bushfire, negatively affects regeneration in trees (Walden *et al.* submitted)

Forest function

The response of forest functioning to drought and bushfire was examined through consideration of the ecophysiological responses of jarrah. Results showed that sites affected by drought and high severity bushfire, had lower pre-dawn leaf water potentials. This response indicates these trees were more stressed than sites that had experienced lower levels of drought. The combination of tree mortality and low pre-dawn leaf water potentials suggests that for jarrah, drought plus bushfire can impact vulnerable portions of the forest (Anderson 2020).

Microbial communities play a key role in forest ecosystems because they perform important functions such as nutrient cycling, litter decomposition and nutrient uptake. An investigation into the soil microbial community found a decrease in fungal richness and diversity with increasing disturbance from drought and bushfire, three years post-bushfire, and distinct changes in community composition in mycorrhizal fungi and pathogens (Hopkins *et al.* in prep.).

RATING

Research has indicated that although the Northern Jarrah forest is generally seen as a highly resilient forest due to its resprouting ability (Matusick *et al.* 2018), vulnerability to drought and heatwaves is evident in shallow-soil areas, altering its structure. In addition, added disturbance such as bushfire can affect the structure, composition, and function of the forest. Longer term studies will indicate whether forest trajectories will return to a pre-disturbance state or be altered in the longer term.

MANAGEMENT RESPONSE FOR THIS FMP

The department has undertaken research and collaborated with other research institutions to improve knowledge on the potential impacts of climate change on forest values. This type of research improves the understanding of impacts of climate change, vulnerabilities and resilience, and will contribute to the prediction of future impacts at a landscape level (such as climate change and bushfire).

Outcomes are communicated to a diverse range of audiences through a variety of avenues, including scientific papers, technical and popular articles, social media, conference talks, seminars and other presentations. A summary of research projects is provided annually in the Biodiversity and Conservation Science Annual Report, which is available on the department's website.

CONSIDERATIONS FOR THE NEXT FMP

The department will seek to:

- maintain capability in forest science.
- continue research into the trends in climate and the impacts on values in the FMP area.
- undertake an evaluation of depth to bedrock across key areas of the FMP area, which could assist with identifying areas of the forest that are vulnerable to drought and heat stress.
- continue to monitor vulnerable sites to identify thresholds of plant survival in a given soil depth, stand structure and moisture availability.
- develop an approach for proactive management of vulnerable sites using climate change as a key driver.

2.13 KPI 13 Adaptive response to changing climate

KPI	Performance target	Year	Achievement	C
13	Adaptive responses to be reported at mid-term and end of term.	2017	—	H
		2021	—	H

BACKGROUND

Increased understanding of the impacts from climate change on forest ecosystems allows predictions of how ecosystems may respond in the future to proactive, management intervention techniques to mitigate the severity of changes, or alternatively the likely outcomes of a 'do-nothing' management scenario.

The department outlined a broad range of activities in the mid-term performance review, that had been undertaken to adapt forest management practices, trial mitigation measures and monitor impacts from the changing climate. Several guidance documents were prepared or revised to incorporate measures enabling management practices to adapt to the drying and warming climate.

The CPC noted the actions that had been implemented at the mid-term performance review and recommended that the department engage and collaborate with research providers, to inform and improve climate adaptation and mitigation.

The CPC also acknowledged that field monitoring would continue through this FMP period to assist in informing decisions regarding the adaptation and mitigation to climate impacts on the forest and noted the commitment within FMP 2014-2023 to undertake a review of silvicultural practices.

STATUS

Biological diversity

Further to the trial translocation of 16 western swamp tortoises from Swan region into sites in the South West and Warren regions in 2016, a further 73 tortoises were released in 2021.

Guidelines for fauna habitat zones to enhance connectivity with riparian areas were developed and mapping of vegetation communities around granite outcrops also occurred during this period of the FMP.

The trend in decreasing rainfall seen as a result of climate change has been accompanied by significant increases in depth to groundwater. Reduced streamflow is causing many once-perennial streams to become ephemeral and many ephemeral streams to become permanently dry. These habitats often contain unique flora and fauna that are not as well adapted to fire and drought. Streamflow and groundwater have been addressed in KPI 10.

Thinning for ecological purposes

In south-west native forests, thinning selectively removes trees from the forest to reduce water competition and increase the amount of water available to remaining trees. The number of trees retained will vary depending on the dominant forest type (jarrah, karri or wandoo), condition of the forest (age and size of trees in an area) and the characteristics of the site.

Experiments in sub-catchments of the Northern Jarrah forest, including 130 hectares in Yarragil forest block, 360 hectares in Cobiac forest block and 1,750 hectares in Chandler forest block, indicate that thinning across at least 40 per cent of a catchment is necessary to provide hydrological benefits in maintaining these forest ecosystems.

Ecological thinning trials are currently being implemented in Munro forest block across a 50 hectare area of even-aged regrowth using current thinning methodologies and techniques. The department is participating in these trials, which form part of a community engagement program organised through the Djarlma working group, led by the South West Timber Hub as part of the *Djarlma plan for the Western Australian forestry industry* (FPC 2019).

Further trials of thinning of jarrah in mine-sites completed at Banksiadale forest block, north of Dwellingup in 2013, contributed to the implementation of the *Interim guideline for the first thinning at age 25 or older of bauxite rehabilitation areas established with native species* (DBCA 2020). The guideline has been implemented in trials at Turner forest block north of Dwellingup.

Impact of drought and heatwaves on thinned catchments

To examine the degree to which drought and heat wave conditions can impact vegetation cover, the thinned Yarragil catchment, and its control catchment, were analysed using remote sensing indices (i35 index) following the method described by Van Dongen *et al.* (2019).

Results indicate that during the 2010-11 drought and heatwave event, vegetation cover decline in the thinned areas in Yarragil was half the magnitude of the unthinned control areas. Similar results were found during the 2015-16 drought and heatwave event.

In the riparian zone of the thinned Yarragil catchment, the vegetation cover decrease was found to be less than in the riparian buffer in the unthinned control area for the 2010-11 heatwave and drought event. These results suggest thinning improved water availability for the remaining vegetation, providing a level of resilience to climate impacts.

Investigating climate ready provenancing

'Climate ready' provenancing seeks to source seed from areas with different climate indicators so it can be used for regeneration projects in areas that are predicted to have a similar future climate regime. This approach can increase the likelihood of a regeneration project being successful in the future.

Field trials in the south-west have provided some evidence of local adaptation in dominant tree species. Trees originating from cool-wet provenances have shown greater growth and resistance to leaf blight (*Quambalaria pitereka*) in trials using marri (Ahrens *et al.* 2019).

A recent heatwave experiment using marri showed that significant plasticity was detected in the warm-dry population in response to water-deficit, with enhanced drought tolerance compared with the cool-wet population (Challis *et al.* 2021).

This research suggests that plants from a warm-dry area were able to adjust to drought better than plants from a cool-wet area.

Research into the impacts of climate change on jarrah, including genetic analysis, showed that precipitation is the most important factor in adaptation to climate change for this species (Filipe *et al.* 2022), suggesting that rather than temperature, rainfall will be a driving factor in the ongoing survival of jarrah. This reflects modelled work that suggests that with rainfall decline, the area able to support jarrah in the south-west is declining (see Maher *et al.* 2010).

Pests

Further research into gumleaf skeletoniser (*Uraba lugens*) has been undertaken since the mid-term performance review. This insect pest has caused large areas of jarrah forest within the FMP area to become defoliated. Research has demonstrated that outbreaks of gumleaf skeletoniser were restricted to the high rainfall areas which had also suffered from coincident longer term and autumn drought events (Wills and Farr 2017).

RATING

During this FMP period, trials to increase the forest's resilience to a drying climate through reducing water competition by thinning has occurred. Drought and heatwave conditions have had an impact on vegetation cover and the research indicates the impact is lower in thinned catchments. Research into climate ready provenancing to source seed for regeneration projects has commenced in the FMP area.

MANAGEMENT RESPONSE FOR THIS FMP

Thinning for ecological reasons may increase ecosystem resilience to a warming and drying climate through reducing competition for water. Thinning trials in the south-west, especially in the high and intermediate rainfall zones, have been shown to increase streamflow and partially reduce declining groundwater tables (Bari and Ruprecht 2003).

Other benefits from forest thinning could include a reduced loss of vegetation cover during climatic extremes such as drought and heatwave events (Ruscalleda-Alvarez *et al.* in prep. increased tree height, and increased crown width of remaining trees (Bhandari *et al.* 2020). These factors are important for providing foraging and habitat for key fauna species.

Further to the research outlined above and in the mid-term performance review, in early 2022 the department convened an independent panel to undertake an expert review of silvicultural practices. The report from the expert panel will provide input into the development of silvicultural settings for FMP 2024-2033.

Approaches to the use of climate ready provenancing have been included in the Florabank Guidelines – Module 5 – Seed sourcing (Harrison *et al.* 2021).

The Phytophthora dieback management manual and guidelines for fire operations relating to prescribed burning have been updated and revised.

CONSIDERATIONS FOR THE NEXT FMP

The department will seek to:

- continue to investigate the response of forest vegetation cover to climate change events, including drought and heatwaves.
- further investigate, with external agencies and research institutions, the ecological impacts of forest thinning.
- undertake further studies on climate ready provenancing to identify the potential for adaptation of dominant tree and understory species for use in revegetation projects.
- consider the recommendations of the independent silvicultural review panel and implement as appropriate.

2.14 KPI 14 Increased knowledge on the amount of carbon stored in forest

KPI	Performance target	Year	Achievement				C
14	Twenty plots established and reported by mid-term and 40 plots by end-of-term.	2017	—				H
		2021	—				H

BACKGROUND

The maintenance of forest carbon stocks is a key indicator of ecologically sustainable forest management. Detailed measurements of carbon within the above and below-ground carbon pools are necessary to develop estimates of carbon storage, and the FMP envisaged plots would be established in those ecosystems for which no data were available to refine forest-wide estimates. This KPI reports on progress to improve knowledge of the amount of carbon stored in forest ecosystems on lands vested in the CPC within the area covered by the FMP. In the absence of new resources to undertake this work, no carbon plots had been established by the mid-term performance review, and the CPC recommended the department prioritise reporting on carbon stores to provide information for the next draft FMP.

STATUS

No comprehensive carbon measurement plots have been established by the department during the period 2014-2021. The department and the FPC have, however, continued to acquire measurements of above-ground woody biomass (hence carbon) in forest ecosystems within State forests and timber reserves, including plantations.

During 2014-2021 a total of 3,826 inventory plots or transects of varied design were measured that can contribute estimates of standing biomass within jarrah and karri State forests and timber reserves. Over 85 per cent of the plots measure the condition and quantity of trees and coarse woody debris remaining after harvesting. The remainder comprise inventory and permanent sample plots measured to provide estimates of growth and yield across forests of varying structure, age and condition. Importantly, the plots also sample a range of disturbance events during this period – timber harvest, bushfire, and drought – that can markedly affect the amount of carbon stored in forests. Similarly, remeasurement of a subset of FORESTCHECK plots and forest thinning experiments has provided further data in two jarrah and one karri forest ecosystem, including areas recovering from bushfire.

RATING

Revised priorities and limited resourcing within the department contributed to the comprehensive carbon plots not being progressed. Resources were targeted toward funded commitments for updating timber inventory in jarrah and karri forests available for timber production, and the remeasurement of existing research and experimental trials (such as thinning experiments and FORESTCHECK).

MANAGEMENT RESPONSE FOR THIS FMP

During this FMP period to 2021, projects by other agencies and universities have also generated data from which detailed carbon storage and change estimates could be derived for specific sites within the FMP area. Walden (2020) measured the changes in carbon storage and forest structure arising from drought and bushfire events at selected sites in the northern jarrah forest. This work was subsequently extended to include estimates of soil carbon at some of these sites.

Since the commencement of FMP 2014-2023, LiDAR or digital imagery datasets have been progressively acquired across approximately 282,000 hectares of forest. These data can be processed to provide improved precision in estimates of standing biomass, while regular updates have occurred to spatial datasets depicting timber harvest history, disease occurrence and areas impacted by bushfires.

Comprehensive measurements of vegetation quantity and structure have also been undertaken for unrelated projects across the FMP area, including for research on fire management, such as investigations to inform fire regimes in banksia woodlands and jarrah tingle forests. Assembly of such datasets presents a further opportunity to improve the estimation of woody biomass (hence carbon) in forest and woodland ecosystems.

CONSIDERATIONS FOR THE NEXT FMP

Revised estimates of forest carbon stored on lands managed by the department will be prepared based on available datasets. This will improve our understanding of the contribution of forests to the mitigation of climate change and inform strategies to address data and knowledge gaps.

The draft FMP 2024-2033 will also promote integrated monitoring across landscapes. Improved sampling of forest ecosystems with limited carbon data will be a consideration in the design of future monitoring and measurement programs.

2.15 KPI 15 The area of native forest and plantations

KPI	Performance target	Year	Achievement	C
15	No permanent loss of net area of forested land due to unauthorised activities.	2017	—	H
		2021	—	H

BACKGROUND

This KPI focusses on the total area of public native forest and plantations on lands vested in the CPC. A stable or increasing area over time underpins both the maintenance of biodiversity and productive capacity. Achievement of this KPI is measured by the changes in area of native forest and plantations; area of forest by land tenure category, including the net area available for wood production; area of forest cleared; and area of forest rehabilitated following mining activities.

The CPC acknowledged the previous achievement of this KPI in 2017, with an overall increase in the area of native forest and only a minor reduction in the area of forest available for wood production. Since the mid-term performance review the area of native forest on lands vested in the CPC has increased significantly due to the acquisition of new reserves, including through the *Plan for Our Parks* initiative announced by the McGowan Government in 2019. This initiative initiative also proposed a significant decrease in the forest area available for wood production through an expansion of Wellington National Park.

STATUS

In 2014, the total area of native forest on lands vested in the CPC was 2,461,500 hectares, with a further 53,900 hectares of plantation (pine and eucalypt) in State forests and timber reserves. During the period 2014-2021, areas of public native forest and plantation continued to be added or excised from CALM Act lands through authorised land tenure changes. The net area of native forest on CALM Act lands within the FMP area increased by 10,300 hectares, while the plantation area decreased by 500 hectares (Figure 18). The net decrease in plantation area excludes 16,500 hectares of fallow land on the Gnangara mound (Pinjar, Gnangara and Yanchep plantations) that are no longer available for pine plantation. During the period to 2021, the net area available for wood production decreased due to changes to informal reserves, including mapping of old-growth forest, fauna habitat zones and proposed tenure.

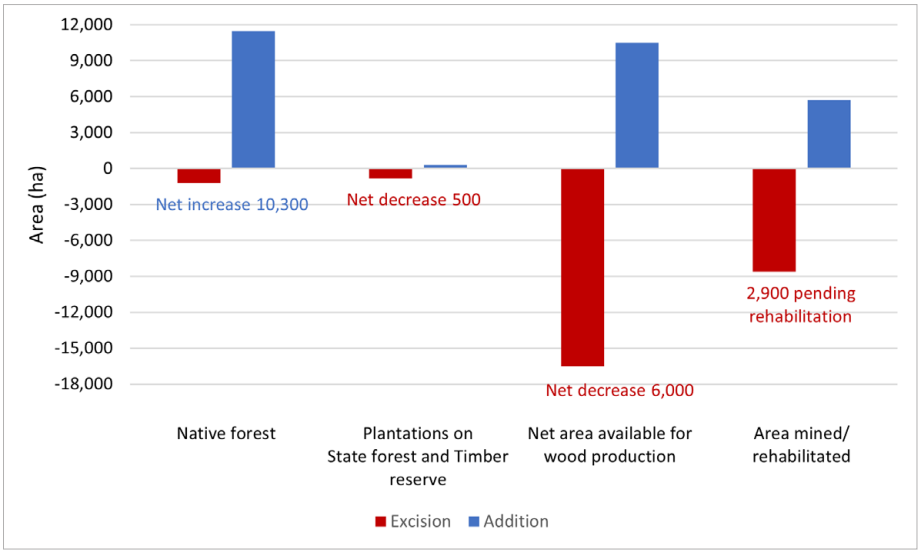


Figure 18. Changes in area of public native forest, plantation, and mined lands during 2014-2021 arising from tenure and other changes.

RATING

Native forest

The net increase of 10,300 hectares of native forest on CALM Act tenures arose from a reduction of 1,200 hectares and an addition of 11,500 hectares.

The decrease in native forest area of 1,200 hectares resulted from the excision of areas to facilitate the construction of new roads, infrastructure corridors, widening of existing easements and land exchanges. Other excisions included removal of some caves from Leeuwin-Naturaliste National Park to facilitate better access for the public. Most of this area was classified as non-forest ecosystems (i.e. shrub, herb and sedgelands and banksia woodland).

Refinement of informal reserve boundaries and the location of fauna habitat zones resulted in an increase of 400 hectares (decrease of 10,100 hectares and increase of 10,500 hectares) of State forest, which has contributed to this rating.

Plantations

A small reduction in total area of plantation by new plantings was offset by excisions arising from several infrastructure projects: the construction of the Perth to Darwin Highway and the Margaret River Bypass Road (50 hectares); the State Explosives Facility in Waroona (130 hectares); and the Western Power Neerabup Terminal (40 hectares). Approximately 300 hectares of the Ludlow and Murray plantations were returned to the department for conservation purposes.

Clearing for mining and mine site rehabilitation

Approximately 8,600 hectares of predominantly jarrah forest was cleared for mining during 2014 to 2021, with 5,700 hectares being rehabilitated following earlier mining operations and 2,900 hectares to be rehabilitated in future years.

MANAGEMENT RESPONSE FOR THIS FMP

During the reporting period, 11,500 hectares was added to the native forest area managed by the department through the acquisition of lands via offset programs, as well as through new reserves proposed in management plans published since commencement of the FMP, such as the *Swan Coastal Plain South Management Plan 2016* (DPaW 2016) and the *Plan for our Parks* initiative. A large proportion of this area comprised jarrah forest, tuart forest, or native non-forest ecosystems.

Since 2014 the area of pine plantation on State forest and timber reserves in the plan area has reduced from approximately 50,500 hectares to 50,100 hectares. This is due in part to infrastructure projects.

An increase in area of State forest of 400 hectares of the native forest available for wood production occurred. This was offset by a decrease of 6,200 hectares from gazetted excisions of State forest tenure, mostly (6,000 hectares) through the expansion of Wellington National Park as part of the *Plan for our Parks* initiative. The remaining 200 hectares was due to minor excisions for road reserves, land exchanges and smaller new proposed reserves.

Rehabilitation of the areas cleared for mine sites was undertaken with 66 per cent of the areas rehabilitated during this FMP period with the remaining 34 per cent to be completed in future years.

CONSIDERATIONS FOR THE NEXT FMP

It is noted that the cessation of large-scale commercial timber harvesting by 2024 will be accompanied by a substantial reduction in the area of public native forests available for wood production.

The department will seek to:

- minimise the reduction in forest area arising from the alienation of lands vested in the CPC for other purposes, including the location of infrastructure.
- continue to acquire forested lands to add to department-managed lands, with a focus on ensuring less-well represented vegetation types and forest ecosystems are added to the formal reserve system. The next FMP will recommend reservation priorities.
- continue to work with the FPC and other agencies to secure additional plantation areas consistent with the *Softwood Industry Strategy for Western Australia* (FPC 2016) and the 2021 announcement to invest $350 million to expand Western Australia's softwood plantation timber industry, and address the future management of fallow areas.
- continue to monitor the annual rate of mining and rehabilitation of areas cleared for mining.

2.16 KPI 16 Removal of log products compared to the allowable cut

KPI	Performance target	Year	Achievement	C
16.1	The cumulative removals of first and second grade jarrah and karri sawlogs shall not exceed the cumulative average annual allowable cut by more than 10 and five per cent at the end of years 3 and 6 respectively, and three per cent at the end of year 9 of the plan, and the total removals over the 10-year plan period shall not exceed the allowable cut.	2017	—	H
		2021	—	H
16.2	No more than the allowable cut of other bole volume of jarrah and karri, and total bole volume of marri logs over the 10-year plan period.	2017	Not due yet	
		2021	—	H
16.3	No more than the allowable cut of wandoo, blackbutt and sheoak sawlogs to be removed over the 10-year plan period.	2017	Not due yet	
		2021	—	H

BACKGROUND

Development of FMP 2014-2023 included calculation of sustained yields for jarrah and karri sawlogs based on the area of State forest available for timber production and approved silviculture and management practices. An annual allowable cut was determined for the 10-year period of the plan, and this KPI monitors the annual removals of forest products relative to the levels set in the plan to ensure log production remains within sustained yield levels. The mid-term performance review reported the level of removals was significantly less than the average annual allowable cut for each species and product, due to prevailing industry, market and economic constraints.

STATUS

The total volume of sawlogs removed through timber harvesting during 2014-2020 remains significantly less than the FMP average annual allowable cut for each species (Table 13). Similarly, other bole volume removals for each species were also substantially less than the pro-rata level at the end of the seventh year of the 10-year plan period.

Product	Volume removed[13] (m3)	Cumulative average annual limit[14] (m3)	% of limit
Jarrah first and second grade sawlog	623,961	924,000	77
Karri first and second grade sawlog	338,163	413,000	82
Jarrah other bole volume	1,215,188	2,044,000	59
Karri other bole volume	903,221	1,148,000	79
Marri bole volume	99,238	980,000	10
Blackbutt first and second grade sawlog	3,320	5,200	64
Wandoo first and second grade sawlog	319	4,400	7

Table 13. Cumulative removal of wood products during 2014 to 2020 by product.

RATING

Reduced levels of sawlog production have continued throughout the reporting period. While the FPC originally contracted lesser amounts than the allowable cut for each species, significant fluctuations in market demand, COVID-related reductions in harvest capacity, the preference to avoid harvest of karri two-tiered forest since 2019, and ongoing structural adjustments within the sawmilling sector have all contributed to the reduced removal of total sawlog.

The low levels of jarrah and marri other bole volume removed was due to reduced market demand for this material, particularly marri.

[13] Note that the information reported here will differ slightly to those in agency annual reports because of adjustments to raw data to reflect log products accepted by customers and off-cuts retained in the forest.

[14] This KPI specifies cumulative targets for the jarrah and karri sawlog removals that are not to be exceeded at years 3, 6 and 9. Figures presented here for all species and products are the pro-rata value over the 10-year period for the lower limits of the allowable cut up to the seventh year.

MANAGEMENT RESPONSE FOR THIS FMP

During this FMP period, product harvested for the market has been significantly less than the total amount of available wood (allowable cut) under the FMP. During this time the amount of product harvested compared to the allowable cut varied, with only 77 per cent of available jarrah and 82 per cent of available karri harvested compared to the allowable level. The low level of wandoo sawlog removal reflects the limited availability of this product within the jarrah harvest coupes accessed during this period.

The reduced levels of marri and jarrah other bole volume removed during harvest operations has had and will continue to have negative consequences for desired silvicultural outcomes and future timber yields.

The FPC and the department will continue to monitor log removals throughout the remainder of the period of FMP 2014-2023 to ensure the allowable limits are not exceeded and that desired silviculture outcomes are achieved where possible.

CONSIDERATIONS FOR THE NEXT FMP

The State Government's announcement that large-scale timber harvesting will cease at the end of 2023 will guide and inform the development of the draft FMP 2024-2033. Forest products, including timber, will only be taken from native forests through management activities that promote forest health outcomes and forest resilience, or ahead of approved mining activities.

2.17 KPI 17 Silvicultural outcomes for the area cutover

KPI	Performance target	Year	Achievement				C
17.1a	Compliance level of 95 per cent against the prescribed requirements assessed by silvicultural outcome (in karri).	2017				—	H
		2021				—	H
17.1b	Compliance level of 95 per cent against the prescribed requirements assessed by silvicultural outcome (in jarrah).	2017		—			H
		2021		—			H
17.1c	Compliance level of 95 per cent against the prescribed requirements assessed by monitoring surveys (in jarrah).	2017		—			H
		2021		—			H

BACKGROUND

Timber harvesting in areas of jarrah or karri forest aims to produce a range of prescribed silvicultural outcomes, depending on the prior structure, species composition, condition of the trees and presence of regeneration within the area. Areas thinned, for example, aim to achieve an outcome of appropriately spaced healthy, vigorous trees, whereas an area harvested to achieve a regeneration outcome requires the retention of suitable habitat trees whilst ensuring a well-stocked regrowth cohort of trees is released from overstorey competition. These outcomes are achieved through a combination of practices undertaken during harvesting and follow-up treatments (such as regeneration burns or the removal of non-merchantable trees that would compete with retained trees).

Incomplete or partially achieved silvicultural outcomes have implications for future forest condition and productivity. This KPI reports on the level of completion of treatments (during or following harvest) and hence compliance with prescribed silvicultural outcomes. The mid-term performance review found that silvicultural outcomes were being achieved in karri forest but only partially achieved in jarrah forest.

STATUS

Silvicultural treatments following harvest to remove the high proportion of remaining unmerchantable trees (and thereby promote regeneration) are not scheduled in areas identified for future mining activity.

Silvicultural outcomes for karri

During 2014-2020 timber harvesting across 8,245 hectares of karri forest achieved objectives in all areas, resulting in the following outcomes:

- 5,738 hectares (70 per cent) were thinned to a prescribed stocking density and condition which focusses overall stand growth onto the retained trees;
- 2,134 hectares (26 per cent) were harvested and planted to establish a regrowth forest of prescribed stocking density and vigour (including regeneration of 99 hectares of mixed karri/jarrah forest); and
- 373 hectares (4 per cent) were harvested and silvicultural treatments were in progress.

Silvicultural outcomes for jarrah

Overall, during the period 2014-2020 silvicultural outcomes consistent with the silvicultural objectives were not achieved across at least 42 per cent of the total 37,229 hectares of jarrah forest harvested. The following outcomes were achieved:

- 2,283 hectares (six per cent) were thinned to a prescribed stocking density and condition which focusses overall stand growth onto the retained trees;
- 2,029 hectares (five per cent) were harvested and existing regeneration was released from suppression by overstorey competition to create a regrowth cohort;
- 2,843 hectares (eight per cent) were harvested with sufficient overstorey trees retained to establish a regeneration cohort;
- 8,062 hectares (22 per cent) of forest infested with *Phytophthora* dieback were harvested to prescribed outcomes;
- 15,645 hectares (42 per cent) were selectively harvested, resulting in stands with a high proportion of non-merchantable trees being retained; and
- 6,367 hectares (17 per cent) were harvested and silvicultural treatments are in progress.

Jarrah monitoring surveys

The jarrah outcomes reported above are corroborated by measurements of retained tree stocking density and condition in 1051 plots sampling stands within 40 jarrah coupes harvested during 2014-2020. Overall, nearly half (47 per cent) of the stands monitored had a density of retained non-merchantable trees (that were available to harvest) which exceeded the prescribed density of less than 12 square metres basal area per hectare. In other words, 47 per cent had a selective outcome following harvesting.

RATING

The trend outlined in the mid-term performance review of only partially achieving prescribed silvicultural outcomes in jarrah forest has continued. In the jarrah forest available for timber production, many areas contain a high proportion of trees that are either too small or of insufficient quality for sawlog. In the absence of commercial markets to utilise these non-sawlog trees, they are retained standing following the harvest. This fails to fully achieve the objectives of releasing the crop trees or the release of regeneration from overstorey competition, and results in a selectively harvested stand. In contrast, these objectives are achieved in the karri forests due to the availability of markets for all log grades.

MANAGEMENT RESPONSE FOR THIS FMP

During this FMP period, monitoring demonstrated that the silvicultural activities conducted in the jarrah forest achieved silvicultural outcomes consistent with the objectives across 58 per cent of the jarrah forest harvested. All the requirements for thinning set out in the FMP were achieved in karri forest. Regeneration of both jarrah and karri forest has been continuing. Until commencement of the FMP 2024-2033, the FPC will continue to monitor and seek to achieve full silvicultural outcomes in all jarrah and karri areas harvested, including through follow-up silvicultural treatments.

CONSIDERATIONS FOR THE NEXT FMP

Areas where silvicultural outcomes have not been achieved or are incomplete can have markedly lower timber yields over the long-term, and potentially some impacts on forest health and resilience. As large-scale commercial timber harvesting will cease at the end of 2023, the potential impact on future timber yields will no longer be a relevant consideration. Areas where a high proportion of non-merchantable trees have been retained following harvest will continue to provide important biodiversity outcomes. Regeneration of harvested forest areas will continue to be monitored under FMP 2024-2033.

2.18 KPI 18 Regeneration of harvested area

KPI	Performance target	Year	Achievement	C
18.1a	For karri and planted jarrah, achieve more than 75 per cent of areas treated to be completed within 18 months.	2017	—	H
		2021	—	H
18.1b	For karri and planted jarrah, achieve 100 per cent of areas treated to be completed within 30 months.	2017	—	H
		2021	—	H
18.1c	For jarrah which has not been planted, achieve 90 per cent of areas treated to be completed within 30 months except in accepted circumstances.	2017	—	H
		2021	—	H
18.2	No more than five per cent of the area regenerated requiring remedial action – jarrah operations.	2017	—	H
		2021	—	H
18.3	No more than five per cent of the area replanted requiring remedial action – clear-felled plantation.	2017	—	H
		2021	—	H

BACKGROUND

Achieving satisfactory regeneration following timber harvesting is an essential requirement for ESFM. While differences in the biological characteristics of karri and jarrah give rise to different approaches to establishing regeneration and acceptable stocking density, in both forest types this should occur within a specified timeframe (18 months in karri, 30 months in jarrah).

In karri forest, areas are replanted to a minimum stocking density after harvesting and regeneration burn. In jarrah forest, satisfactory regeneration can be achieved following a silvicultural burn through seedfall from retained overstorey trees and subsequent seedling establishment.

The mid-term performance review noted that more than half of the jarrah areas were not achieving the 30-month target for post-harvest regeneration treatment, due to the challenges of completing silvicultural burns within the overall department's prescribed burning program. Refinements to the scheduling and prioritisation of these burns were foreshadowed.

STATUS

Karri

During the period 2014-2020, assessment of 80 completed karri coupes indicates all regeneration treatments were completed within the required period of 18 months since harvest and regeneration was effective.

Jarrah

A substantial proportion (approximately 44 per cent) of coupes are awaiting regeneration treatments but are still within the acceptable 30-month timeframe. The effectiveness of regeneration in jarrah forest coupes (informed by field observations and silvicultural records) was fully achieved and no areas required remedial regeneration during this period.

RATING

A persistent focus within the FPC and the department on achieving timely and effective karri regeneration outcomes has continued to deliver sound results across the seed collection, nursery production, silvicultural burning and planting programs.

A renewed focus within the department since the mid-term performance review on completing the scheduled silvicultural burning program has enabled a substantial reduction in an earlier backlog of areas requiring regeneration. Nevertheless, achieving the 30-month target for all jarrah post-harvest regeneration treatments remains challenging within the broader priorities and availability of suitable weather conditions for the department's prescribed burning program.

MANAGEMENT RESPONSE FOR THIS FMP

To support achievement of the performance targets set out in the FMP 2014-2023, additional resources were made available to undertake an assessment of 113 jarrah coupes harvested during the period 2014-2020. Results indicate the targets for timeliness of regeneration treatments were mostly achieved, with only 16 per cent of areas where regeneration was due to be completed by the end of 2020 not meeting the 30-month target.

For karri, over 80 per cent of the areas identified for regeneration were completed within 18 months. Surveys across the coupes indicated the regeneration was effective, and all monitoring demonstrated that silvicultural stocking standards had been met.

CONSIDERATIONS FOR THE NEXT FMP

Prioritising jarrah silvicultural burns within the overall prescribed burn program will be essential to completing treatments in areas already harvested and awaiting regeneration treatment.

Adequate resourcing will be necessary to ensure silvicultural burns are undertaken and regeneration outcomes achieved for those karri and jarrah areas harvested between 2021-2023, as these activities will need to continue for a period beyond the cessation of large-scale commercial timber harvesting at the end of 2023.

2.19 KPI 19 Plantations are managed to meet obligations under State Agreements and production contracts

KPI	Performance target	Year	Achievement				C
19	The total annual volume of each log grade delivered compared to supply obligations (arising from State Agreement Act and other contracts applicable during the plan period).[15]	2017				—	H
		2021				—	H

BACKGROUND

Plantations of pines and eucalypt species have been established within the FMP area for the purpose of supplying wood products to industry. The FPC has obligations to supply specific annual quantities of plantation timber products to industry.

The volume of timber and log products that FPC supplies varies annually, depending on the demand for product. In the mid-term performance review, it was reported that demand fluctuated over the reporting period (2012-13 to 2016-17), with the actual supply of sawlogs and industrial wood products available exceeding the budgeted requirements in most years. The FPC worked with its customers to manage changes in supply and demand. In 2015, $21 million was approved to be reinvested over the subsequent five years to assist FPC to continue to provide and supply timber products to the market.

It was also identified in the mid-term performance review that the area of plantation resources was predicted to decline making it difficult for log product demand to be met into the future. The impacts of projected shortfalls in the supply of softwood product would be managed by FPC and the industry through supporting increased plantation establishment on a mix of State government and private land.

STATUS

Contracts of sale generally include a maximum amount of log product that FPC is required to supply. These contracts include provisions for customers to reduce the amount of product required in the year depending on market demand and alternative sources of supply. As a result, the demand for budgeted log product has fluctuated during the FMP period (2014-2021).

In the period 2017-18 to 2020-21, the supply of product has been close to budgeted demand for all products, although sawlog production fell behind budgeted demand in 2017-18 and 2018-19 (Figures 19 and 20)[16]. The demand for sawlog increased in 2017-18 and then remained steady at an average of approximately 611,000 m^3 per year while the average actual supply was approximately 590,000 m^3 per year. Softwood production was on average approximately 327,000 m^3 per year while the average demand was slightly greater at approximately 331,000 m^3 per year.

RATING

For the majority of the FMP period (2014-2021), FPC has met the market demand for plantation products. The decline in the capacity of the plantation estate is due partly to the exit of single rotation sharefarm agreements.

Communication, collaboration, and strong working arrangements between FPC and its customers allow the short-term changes in supply or demand to be managed. These changes may be caused by plant breakdowns, variation in market cycles, or bushfires. Bushfires that affect the plantation area may require salvage programs, which create changes in the supply of product. Export markets create short-term opportunities to meet plantation supply objectives when prices are favourable.

[15] Data provided by the FPC.

[16] Plantation wood production reported is for the entirety of the softwood estate.

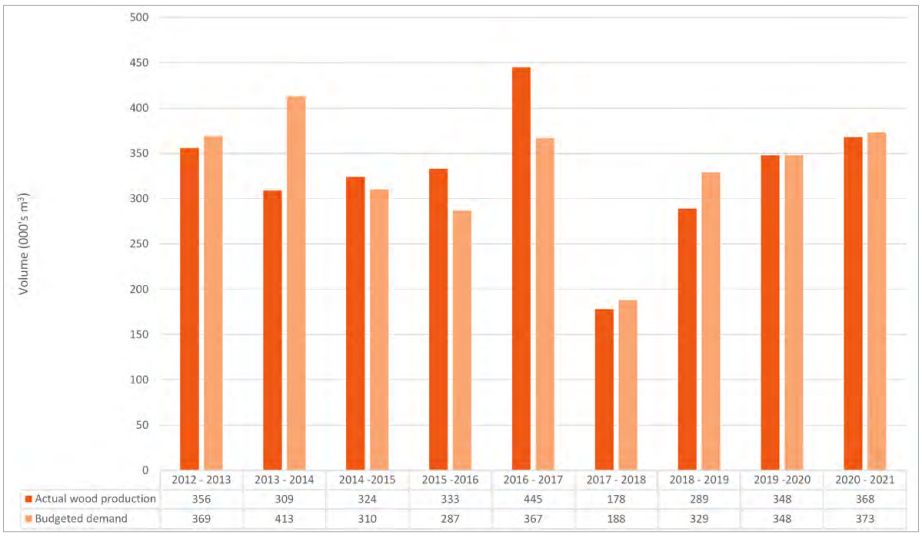


Figure 19. Sawlog production actual supply against budgeted demand (000s m^3).

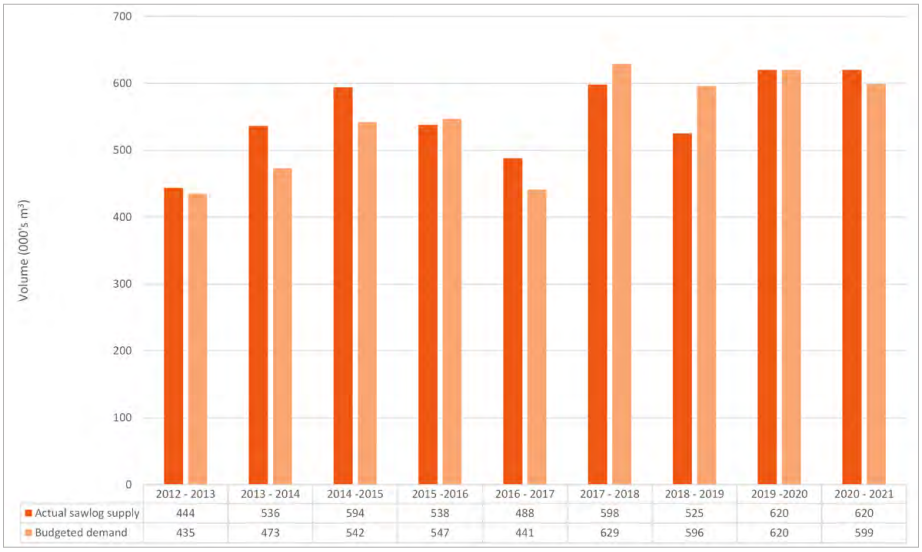


Figure 20. Industrial softwood production as compared to budgeted demand from industry (000s m^3) (variation between contracts and deliverables can occur as reports are finalised prior to final figures).

MANAGEMENT RESPONSE FOR THIS FMP

The supply of native timber was predicted to decline during FMP 2014-2023 and into the future. To ensure a sustainable core plantation estate in the future, FPC committed to working with industry to minimise these impacts and address the predicted shortfalls by continuing to develop and establish plantations. The implementation of the *Softwood industry strategy for Western Australia* (FPC 2016) continues to build the timber resource and land required for the FPC to meet its contractual obligations.

In addition, the Western Australian Government announced an additional $350 million investment in September 2021 to expand the softwood estate over the next 10 years. The intent of the investment is to maintain a productive plantation estate and build the capacity of the pine plantation estate to meet anticipated future market demands.

CONSIDERATIONS FOR THE NEXT FMP

Consideration will be given to re-establishing plantation areas, within areas of State forest that are currently fallow.

2.20 KPI 20 Consultation and involvement of Noongar people

KPI	Performance target	Year	Achievement	C
20.1	Establishment of at least six joint management arrangements under the CALM Act by 2023.	2017	Not due yet	H
		2021	Not due yet	H
20.2	Local area arrangement and protocols for Aboriginal customary activities established and implemented within each district of the department in the plan area by 2023.	2017	Not due yet	H
		2021	—	H
20.3	Appropriate and representative Noongar groups to be consulted and invited to provide input into all management plans.	2017	—	H
		2021	—	H

BACKGROUND

An overall goal of FMP 2014-2023 is to protect and conserve the value of the land to the culture and heritage of Noongar persons and to protect Noongar cultural sites.

The department provided an update on the establishment of joint management arrangements, local area arrangements and protocols and consultation with Noongar groups in the mid-term performance review. The department advised under the SWNTS, Co-operative Management Committees (CMCs) would be established to identify and establish joint management agreements. It was identified that a small number of Local Area Arrangements had been developed within the FMP area and that consultation with Noongar groups is routinely undertaken through the development of CALM Act management plans.

The CPC acknowledged the involvement and consultation of appropriate and representative Noongar groups in the development of management plans within the FMP area.

STATUS

20.1. Establishment of at least six joint management arrangements under the CALM Act by 2023.

As of March 2022, co-operative or joint management arrangements have not been established in the FMP area. This is a result of delays with the SWNTS, which came into effect on 25 February 2021.

As part of the Settlement, new Noongar Regional Corporations are currently being established in a process facilitated by the South West Aboriginal Land and Sea Council (SWALSC). The department and the Noongar Regional Corporations will enter into co-operative and joint management agreements for the South West Conservation Estate, including lands covered by FMP 2014-2023.

20.2. Local area arrangements and protocols for Aboriginal customary activities established and implemented within each district of the Department in the plan area by 2023.

A total of six local area arrangements for customary activities are in place in the FMP area. This includes five arrangements in Swan Region with Whadjuk Noongar people and one arrangement with Wagyl Kaip and Southern Noongar people in Warren Region. All local area arrangements provide access to lands for the customary purpose of hunting.

20.3. Appropriate and representative Noongar groups are consulted and invited to provide input into all management plans.

Consultation with appropriate and representative Noongar groups is routinely undertaken, both formally and informally, through the development of CALM Act management plans. Consultation has occurred for the preparation of a preliminary draft management plan for *Parks of the Darling Range* (covers four regional parks, 10 national parks and other CALM Act reserves in the Perth Hills) and the *Kalgulup Regional Park Management Plan 2021* (DBCA 2021).

Consultation and Noongar engagement efforts for these management planning processes have included: presentations at Whadjuk and Gnaala Karla Booja working party meetings; Noongar Elder representation on community advisory committees; field trips with Elders; and meetings with Elders to discuss vision, cultural heritage content, park names and branding, and cultural heritage interpretation opportunities.

CONSIDERATIONS FOR THE NEXT FMP

Consultation with SWALSC commenced in January 2022 to understand how the planning process for FMP 2024-2033 can capture information necessary to reflect the statutory requirement to protect and conserve the value of the land to the culture and heritage of Aboriginal people. This will include incorporating the necessary mechanisms into FMP 2024-2033 to meet the requirements of the SWNTS and CALM Act objectives to conserve and protect Noongar cultural and heritage values.

The department is committed to joint management and partnership opportunities with traditional owners. As part of the SWNTS, the department and six Noongar Regional Corporations will enter into Co-operative Management Agreement and Joint Management Agreement arrangements for the care and protection of identified areas in the South West Conservation Estate. The department and the Noongar Regional Corporations, through six CMCs will work together to put in place management plans that include joint management arrangements over areas of the South West Conservation Estate. Specific consultation and engagement processes will be captured and addressed in FMP 2024-2033.

2.21 KPI 21 Social and economic benefits from the timber industry

KPI	Performance target	Year	Achievement	C
21.1a	All high value sawlog resource processed or value added locally. [17]	2017	—	H
		2021	—	H
21.1b	An increase in low value resource taken on by local markets.[17]	2017	—	H
		2021	—	H
21.2	Increased local processing capacity.[17]	2017	—	H
		2021	—	H
21.3	Employment and social benefits maintained or increased.[17]	2017	—	H
		2021	—	H

BACKGROUND

Maintenance and enhancement of long-term multiple socio-economic benefits of forests to meet the needs of societies is one of the criteria underpinning ESFM. State forests and timber reserves within the FMP area provide native forest hardwood and plantation-grown softwood products and result in socio-economic benefits for local, regional and State economies and communities. Socio-economic benefits are an important consideration for ESFM outcomes. For the period of FMP 2014-2023, the forest products industry (timber harvesting) has been the focus for considering social and economic benefits to the community.

A range of activities were identified in the mid-term performance review that contributed to maintaining socio-economic benefits from the industry including the local processing of sawlogs, a study that considered the value of the industry to employment generation and a survey of processors that identified the need for new investment.

Information was also included about investments in new technology, policy direction and the consolidation of operations to gain greater efficiencies.

The CPC noted the information provided and that there are further opportunities for increased local processing of timber products.

STATUS

The key indicators of economic benefits of the forestry industry in Western Australia to 2015-16 (Schirmer *et al*. 2017) reported in the mid-term performance review have been re-assessed to the end of financial year 2019-20 (Magnusson and Angelakis 2022). In 2019-2020, the value of primary processed products (including firewood) was $645 million at the point of sale. This represents a decrease compared to $649 million in 2015-16, noting this figure excluded firewood.

21.1a All high value sawlog resource processed or value added locally

As outlined in the mid-term performance review, there is a requirement in the contracts of sale for customers purchasing sawlog quality material to commit to domestic processing. All first and second grade sawlogs were processed locally. It is not possible to report what volume of value-added product was generated due to the information being commercial-in-confidence.

The direct Gross State Product[18] (GSP) contributed by the WA forestry industry in 2019-20 at the point of sale of primary processed products (including firewood) was $313 million, increasing to $669 million when flow-on effects generated in other industries are included. This compares to direct GSP of $257 million or total GSP of $643 million in 2015-16, which excluded firewood.

[17] As assessed by the FPC

[18] Gross state product is a measure of the value contribution of an activity to the State economy. From an expenditure perspective, GSP is measured as value of output less the cost of goods and services (including imports) used in producing the output. From an income perspective, it represents payments to the primary inputs of production (labour, capital and land) and net taxes.

21.1b An increase in low value resource taken on by local markets.

Low value resource product used within local markets increased from 63 per cent in 2015 to 76 per cent in 2020 for jarrah, and from 71 per cent in 2015 to 74 per cent in 2020 for karri.

21.2 Increased local processing capacity.

Local processing capacity has remained steady. The local processing of products provides direct and indirect employment opportunities.

21.3 Employment and social benefits maintained or increased.

The industry generated 2,580 direct jobs up to the point of primary processing in 2019-20; the estimated flow-on employment generated was an additional 2,678 jobs. The industry as a whole supported the employment of around 5,258 people up to and including the point of primary processing, including firewood and associated flow-on effects. This compares to direct employment of 2,114 jobs or total employment of 4,570 jobs from primary processing in 2015-16 (excluding firewood).

The estimated secondary processing employment has not been updated since the 2015-16 estimate of 1,495 jobs.

RATING

An increase in the low value resource of jarrah and karri used within local markets occurred between 2014-2020.

Forestry from forest and plantation establishment and primary processing of the product employed 466 more people in 2020 than in 2015-16. Employment including downstream or further processing (for example, furniture making) grew by 688 since 2015-16.

State-wide policy has supported the local forestry industry through its buy local policies, the *Softwood industry strategy for Western Australia* (FPC 2016), the *Djarlma plan for the Western Australian forestry industry* (FPC 2019) and conditions of the contracts of sale of forest products.

MANAGEMENT RESPONSE FOR THIS FMP

Implementation of the *Softwood industry strategy for Western Australia* (FPC 2016) has been a major achievement during this FMP period. Conditions of sale ensure local processing of the product providing significant employment opportunities across the FMP area, including up to the point of primary processing and in secondary and downstream processing of forest products.

CONSIDERATIONS FOR THE NEXT FMP

Notwithstanding the change in policy relating to native forest timber harvesting, the FPC continues to work collaboratively with industry and communities to support the current and expanded future softwood plantation estate to meet the softwood timber needs of the Western Australian community. This work includes monitoring the socio-economic benefits of the forest industry.

Broader consideration may also be given to socio-economic benefits generated by other industries that rely on south-west forests.

2.22 KPI 22 Visitation, facilities and visitor satisfaction

KPI	Performance target	Year	Achievement	C
22.1	Level of visitation to be maintained or increased.	2017	↗	H
		2021	↗	H
22.2	No target, trends to be reported (recreation and tourism facilities).	2017	No target	H
		2021	No target	H
22.3	Visitor satisfaction to meet or exceed departmental benchmark.	2017	—	H
		2021	—	H

BACKGROUND

Monitoring of visitor satisfaction and the provision of recreation and tourism facilities helps to determine if the range and quality of those facilities are being maintained or improved.

The mid-term performance review found that the performance target for this KPI had been achieved and was improving. The increase in visitor numbers and level of visitor satisfaction was noted by the CPC.

STATUS

The performance targets for the KPI have continued to be achieved since the mid-term performance review.

22.1 Level of visitation

Reportable visitation has increased by 28 per cent across the reporting period, from 9.7 million during 2013-14 to 12.4 million during 2020-21, achieving the performance target of the level of visitation to be maintained or increased (Figure 21).

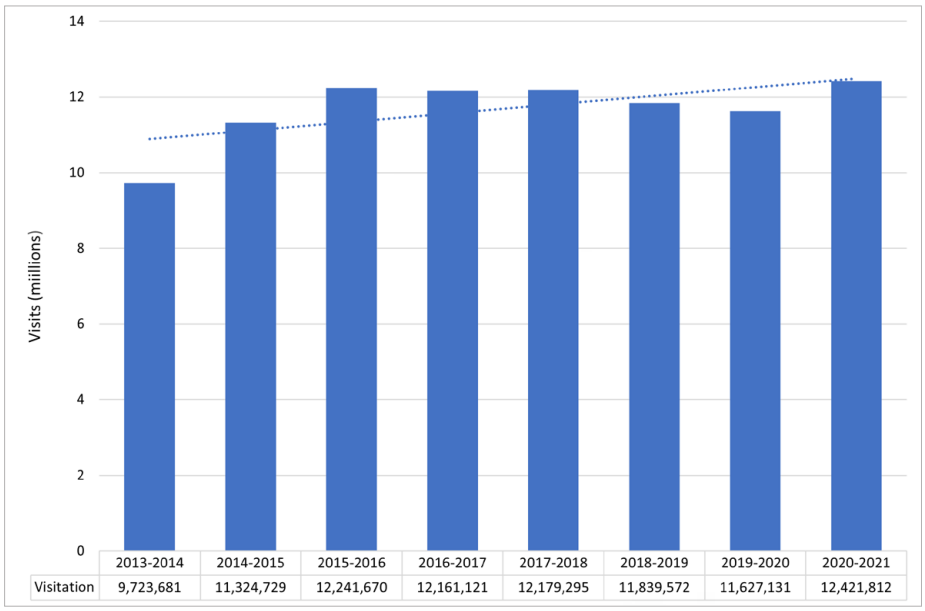


Figure 21. Annual visitation to recreation sites in the plan area from 2013-2021.

22.2 Type and number of recreation and tourism facilities available in the plan area

The department maintains a database of recreation and tourism facilities provided at visitor sites. There was an increase in the number of recreation and tourism facilities provided in all asset types from 12,300 in 2013-14, to 32,400 in 2017-18 and 34,400 in 2020-21 (Table 14 and Figure 22). Miscellaneous facilities include gates, fences, and water tanks at each recreation site. Site works includes campgrounds and parking areas, and furniture includes picnic tables, barbecues and seats. From 2016-17, bollards and wheel stops have been included individually rather than collectively at each site, resulting in a significant increase in the number of facilities recorded.

Facility	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Buildings	562	581	594	627	635	637	639	677
Furniture	1,299	1,077	1,077	3,430	3,583	3,600	3,607	3,619
Miscellaneous	1,550	1,580	1,588	14,478	15,483	16,661	16,720	16,850
Signs	6,424	6,731	6,799	9,721	9,710	9,947	10,106	10,229
Site Works	519	523	530	550	574	576	582	584
Structures	1,394	1,393	1,772	1,783	1,805	1,807	1,821	1,835
Trails	439	458	452	455	460	462	472	489
Other equipment	116	128	125	135	132	131	131	131
Total	12,303	12,471	12,937	31,179	32,382	33,821	34,078	34,414

Table 14. Annual visitation to recreation sites in the plan area from 2013-2021.

22.3 Visitor satisfaction

Visitor satisfaction has consistently remained above the departmental benchmark (85 per cent) for the duration of the reporting period, rising from approximately 90 per cent in 2013-14 and 2017-18 to 94 per cent in 2020-21, achieving the performance target to meet or exceed the department's benchmark of 85 per cent (Figure 23).

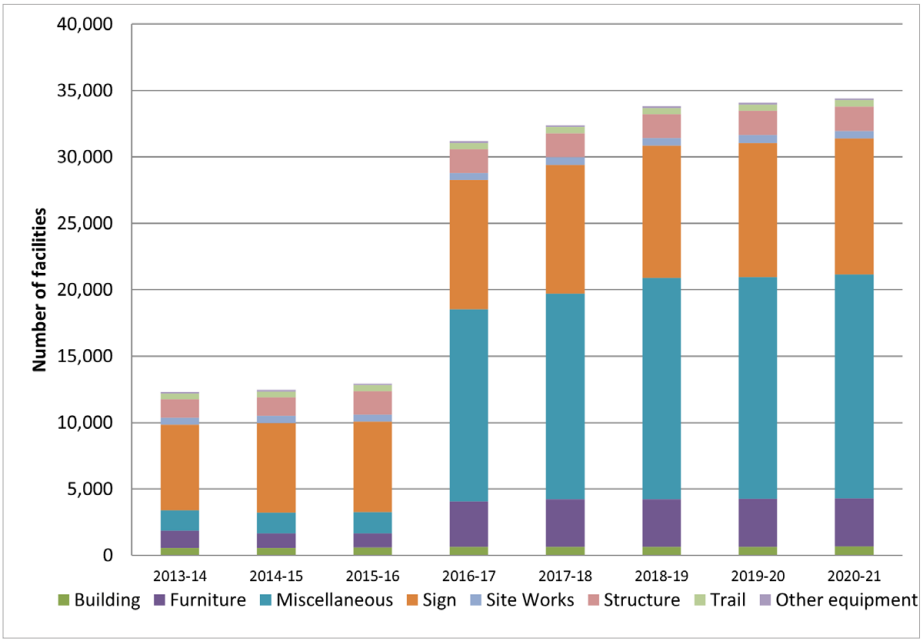
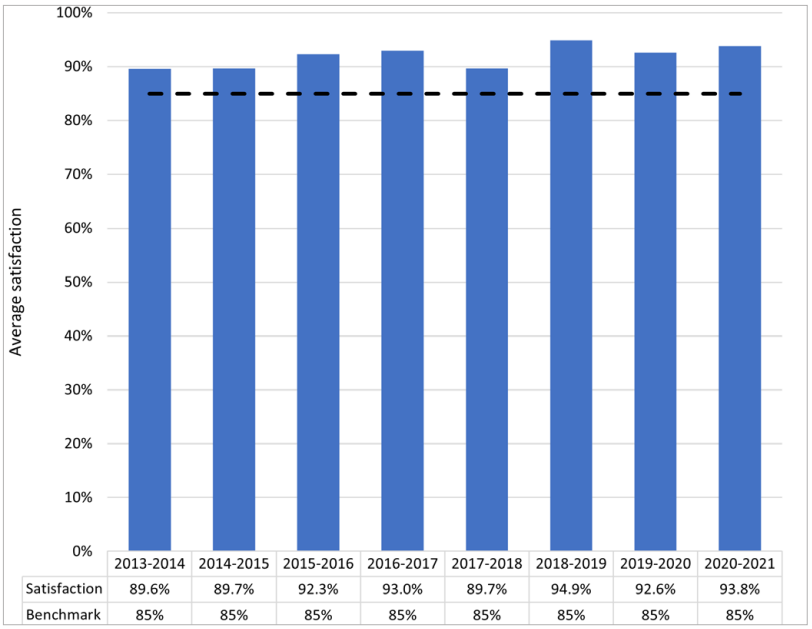


Figure 22. Type and number of recreation and tourism facilities available in the plan area.



	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
Satisfaction	89.6%	89.7%	92.3%	93.0%	89.7%	94.9%	92.6%	93.8%
Benchmark	85%	85%	85%	85%	85%	85%	85%	85%

Figure 23. Visitor satisfaction at recreation sites in the FMP area from 2013-2021.

RATING

22.1 Level of visitation

As outlined in the mid-term performance review, approximately 1.8 million of the 2.7 million increase in visitation across the period was attributed to improvements in monitoring at Leeuwin-Naturaliste National Park, Rockingham Lakes Regional Park and Woodman Point Regional Park between 2013-2015.

In 2019-20, there was an increase in visitation in parks closer to Perth, such as John Forrest National Park, as a result of COVID-related lockdowns and border restrictions. The remainder of the change appears to be due to increased visitation at monitored recreation sites, with 2020-21 being the highest recorded year after recovering from the impacts of COVID-19 travel and associated restrictions in the preceding year. In 2020-21, some examples where visitation increased beyond pre-COVID visitation levels include Lane Poole Reserve, Leeuwin-Naturaliste National Park, and Walpole-Nornalup National Park, with parks closer to Perth returning to pre-COVID visitation patterns.

There were a number of new and upgraded recreation sites and campgrounds across the area also supporting increased visitation.

22.2 Type and number of recreation and tourism facilities available in the plan area

As outlined in the mid-term performance review, the increase in asset numbers across all asset types was due in part to the construction of new campgrounds (Jarrahdene, Contos, Shannon, Potters Gorge, Logue Brook and Lake Kepwari), establishment of new visitor facilities (Wiilman Bilya walk trail and mountain bike trails at Arklow, Westralia and Wellington), construction of new roads (Lake Kepwari) and replacement of old timber bridges with concrete and steel products.

22.3 Visitor satisfaction

Satisfaction has remained consistently high and is in line with the statewide average. Investigations into the specific reasons for the level of visitor satisfaction are not undertaken by the department unless there is a decrease of five per cent or more in any one year, which has not occurred for recreation sites in the FMP area.

CONSIDERATIONS FOR THE NEXT FMP

The department will continue to monitor visitation and visitor satisfaction and record the type and number of recreation and tourism facilities available in the FMP area.

2.23 KPI 23 Maintaining an effective strategic road network

KPI	Performance target	Year	Achievement	C
23	Access via strategic road network to be maintained.	2017	↘	H
		2021	↘	H

BACKGROUND

The strategic road and bridge network is essential for the department to perform its functions and the condition of the network impacts on commercial and community users. Assessment of this KPI involves the review and assessment of the road and bridge network, including comparison of the total expenditure compared to national road preservation models.

The mid-term performance review identified that the essential road network was maintained and available for use, however, it was noted that without continued investment the roads would become rougher and more hazardous. Bridge maintenance and replacement was identified as a priority and it was reported in the mid-term performance review that a strategic bridge replacement and maintenance program had been implemented.

The CPC recommended that additional funding be sought and allocated to maintaining the strategic road network to improve public safety and access for bushfire suppression. The department submits a business case for additional funding to maintain and improve the strategic road network every five years.

STATUS

Across the lands managed by the department within the FMP area, approximately 14,500 kilometres of roads and tracks form the strategic road network. The department commissioned Talis Consultants to undertake a valuation of the road network, including an assessment of the condition, with a report provided in October 2017 (Talis 2017). The report recognised that the department manages the most extensive road network of any road management agency within Western Australia. The overall condition of the network was assessed as poor. For sealed roads, major reconstruction work is required to avoid serious deterioration that could result in road closures.

The performance target for the KPI has been met for parts of the FMP area. In 2016-17, review and assessment was completed in the South West and Warren Regions representing 59 per cent of the road network across the FMP area. This is below the target to review and assess 80 per cent of the road network every five years, and is due to the assessment of the road network in Swan Region that was scheduled for 2018 not being completed.

Expenditure on the road network and bridges has increased in the FMP area. Of the annual preservation target for the road network, 34 per cent was spent in 2014-15, 36 per cent in 2017-18 and 57 per cent in 2020-21. This remains well below the target of 80 per cent of estimated preservation[19] funds required (based on 2014 figure plus two per cent average Consumer Price Index increase, including changes to the road network) (Figure 24).

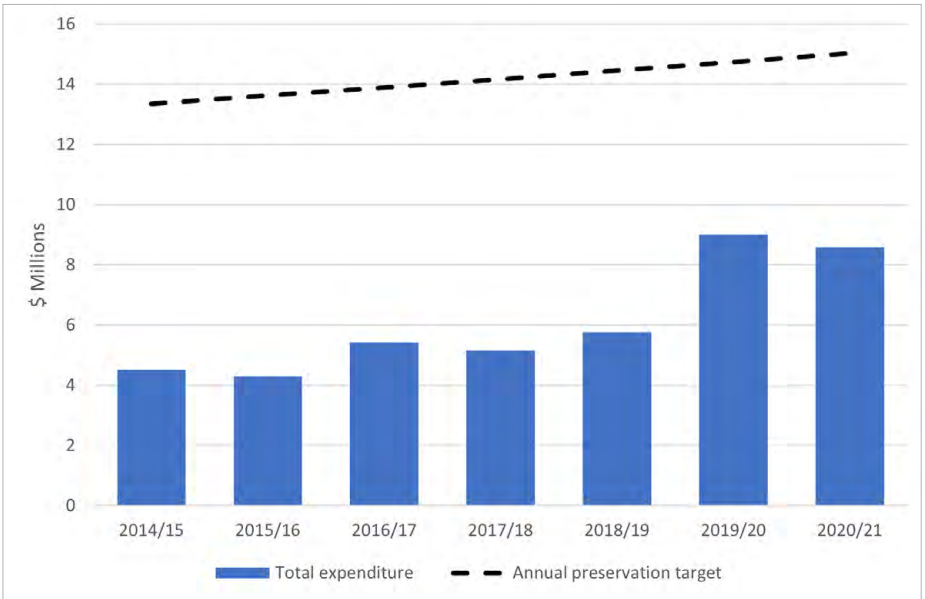


Figure 24. Total annual expenditure on the road network within the FMP area and the estimated annual preservation target for the strategic road network.

As outlined in the mid-term performance review, a dedicated strategic bridge replacement and maintenance program has been effective over the last 10 years, with at least one third of available funding being allocated by the department to keep bridges open. Maintenance and replacement of bridges within the strategic road network is a priority and the percentage of bridges that are closed or are load limited has decreased significantly since this program commenced in 2012.

During the FMP reporting period (2014-2021), 81 bridge replacements and 24 culvert replacements have been undertaken. The number of closed or load posted bridges continued to reduce in each financial year to 2021, achieving the aim of two per cent each year. The number of bridges closed or restricted is variable throughout the year.

RATING

The strategic road network continues to be assessed and reviewed consistent with policy objectives. Dependent on maintenance priorities, backlogs and available funding, the strategic network will remain safe and functional. A strategic approach to classification, condition-scoring and maintenance of the road network has enabled available funding to be directed to the highest priority roads and bridges within the network.

However, with a significant and ongoing funding deficit, the department is unable to preserve the condition and extent of the entire network, resulting in many roads being downgraded either by type and/or category. The outcome will be a smaller but functional network of roads and tracks.

CONSIDERATIONS FOR THE NEXT FMP

Consistent with the roads policy, the department will continue to implement a strategic approach to the classification, condition-scoring and maintenance of the road network directing available funding to the highest priority roads and bridges in the FMP area.

The department will continue to seek additional funding for road maintenance to achieve the preservation target required for the identified road network. The strategic bridge replacement and maintenance program will continue to be delivered.

As the status of bridge and culverts is restored to an operational level, funds will be directed to restoring a maintainable surface for the unsealed road network within the FMP area.

[19] Required preservation expenditure is the estimated cost of maintaining roads at their current condition.

2.24 KPI 24 Extent to which the institutional framework supports the conservation and sustainable management of forests

KPI	Performance target	Year	Achievement				C
24.1	Guidance documents to be prepared and/or reviewed as required during the period of the plan.	2017				—	H
		2021				—	H
24.2a	Research projects address identified high priority knowledge gaps.	2017				—	H
		2021				—	H
24.2b	Peer reviewed articles are produced by research projects.	2017				—	H
		2021				—	H
24.2c	Knowledge gained is communicated to policy makers and operational managers.	2017				—	H
		2021				—	H
24.3a	Public attendance for key education awareness and extension programs to be maintained.	2017				—	H
		2021				—	H
24.3b	Volunteer contribution (number of volunteers and volunteer hours) to be maintained.	2017				—	H
		2021				—	H

BACKGROUND

The department's institutional framework includes a range of elements that combine to provide and serve the purpose and intent of an environmental management system for the FMP area. Elements follow a hierarchical structure and include the forest management plan, policy, guidelines, manuals and procedures that guide the management and operational activities that occur.

This KPI assesses the success of the implementation of FMP 2014-2023 in achieving its targets by tracking preparation and review of subsidiary guidance documents, improvement in scientific understanding of ecosystem characteristics and functions and the maintenance of community participation through eco-education and volunteer programs.

The mid-term performance review reported that several documents including guidelines and manuals used to assist in the implementation of FMP 2014-2023 had been updated. An overview of research to address knowledge gaps in ESFM that had been published during the FMP period (2014-2017) was also provided.

It was outlined in the mid-term performance review that volunteer numbers and contributions during the FMP period (2014-2017) had an overall increasing trend. The department has maintained communication with volunteer groups, the public, external stakeholders, the scientific community and other Government agencies.

The CPC acknowledged the manner in which the institutional framework supported the conservation and sustainable management of forests.

STATUS

Guidance documents

Building on the completion of all guidance documents, as reported in the mid-term performance review, the department is currently updating a number of policies, guidelines, procedures and technical reports. In relation to the policies referred to in FMP 2014-2023, 18 policies are under review. One interim report, two manuals, four procedures, seven forms and one field guide have been updated or revised.

The implementation of DAS since 2018, has enabled a more rapid and efficient approach to aassessing and approving operations (where appropriate) carried out on department-managed lands. DAS is an online system used to process and record all disturbance operations occurring on department-managed lands within the FMP area and across the State.

Scientific understanding

Research has continued since the mid-term performance review including into the effects of a drying climate, thinning for forest resilience, pests and diseases, 'climate provenancing' and bushfire impacts. Thirty-seven peer-reviewed papers have been published from January 2018 to December 2021, building on the 54 papers that were reported in the mid-term performance review. The FORESTCHECK monitoring program has continued to be implemented throughout the FMP period (2014-2021). As outlined in the mid-term performance review, the department continues to communicate the research findings through a range of forums and mechanisms.

Public education and volunteer contributions

The department conducts a range of community education programs relevant to the management of lands and values within the FMP area. Volunteer numbers and contributions decreased during the 2018-19 and 2019-20 financial years but have recovered in 2020-21 (Figure 25). The Nearer to Nature program located in the Perth Hills District has continued to maintain public attendance up to the 2020-21 financial year. Since then, numbers have not recovered to previous levels which in part is due to the ongoing impacts of COVID-19 restrictions.

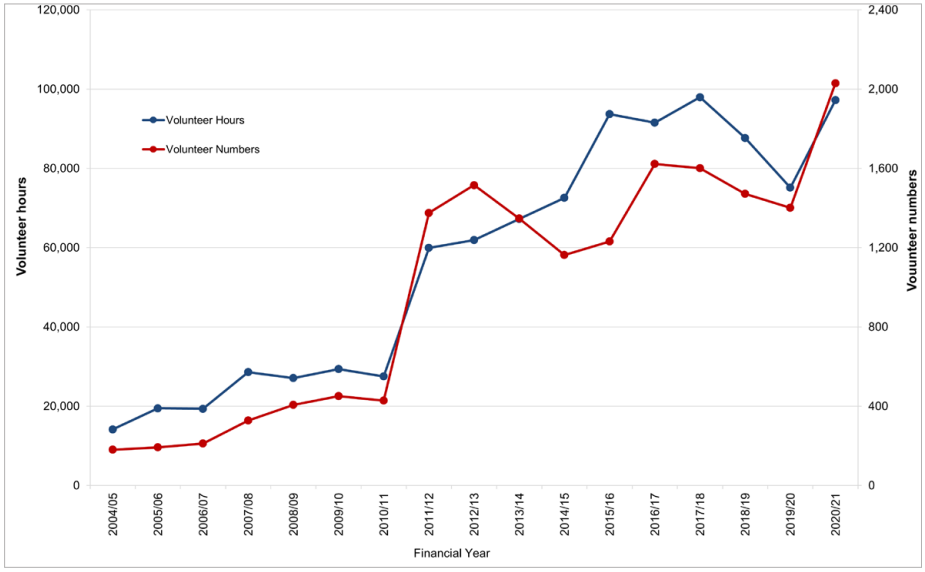


Figure 25. Volunteer numbers and hours.

RATING

Guidance documents are in place for the management and implementation of FMP 2014-2023. These documents either remain current or are updated as required by the department.

DAS continues to be implemented by the department to manage impacts to values within the FMP area. Management actions required through the assessment process established through DAS, are guided by approved documents and guidelines. Adaptive management trials, monitoring and evaluation of disturbance activities and management actions contribute to increased knowledge and understanding of forest management.

Investment in research has been maintained at a similar level to that reported in the mid-term performance review. The peer reviewed papers department scientists have authored or co-authored since the mid-term performance review have focussed on high priority knowledge gaps, related to the ecologically sustainable management of forest ecosystems. Collaboration with other agencies and partners has assisted increased knowledge on several factors which effect the forest ecosystem such as fire, insect pests and genetic variability within species.

The department relies on the contribution of volunteers to achieve many conservation-based management outcomes and the work of volunteers is highly valued. Volunteers also contribute to research projects that are presented in peer reviewed publications. During FMP 2014-2023, the global COVID–19 pandemic impacted a number of programs that relied on the in-kind support of volunteers. The availability of volunteers during this time reduced due to movement restrictions and lockdowns. The number of registered volunteers with the department, and the number of hours volunteered, decreased during 2019-20. Following the easing of restrictions, volunteer numbers have increased above pre-pandemic levels, while the hours contributed by volunteers is consistent with pre-pandemic levels.

MANAGEMENT RESPONSE DURING THIS FMP

The development of new, or revision of existing guidance documents, is informed by knowledge gained through scientific research or improved management strategies and operational practices. This ensures that the system for environmental management is maintained and responds to improved knowledge, changes in technology and conditions, and reflects contemporary practices.

The department has maintained forest science capability and conducted research to enhance ESFM throughout the period 2014-2021. This has resulted in extensive publication of peer-reviewed scientific papers, in both Australian and international journals. The department's science projects and research are aligned with the department's service priorities. For science related to managing forests, the applicable priority is to undertake scientific investigations that are effectively targeted to improve biodiversity knowledge and integrate science knowledge into biodiversity conservation and management. Current research themes for the department relate to the use of remote sensing approaches to inform the development and delivery of landscape scale management, developing models to determine the effects of human-induced climate change on biodiversity, and research relating to weeds, plant diseases, pest animals and related conservation and management actions.

The department has continued to deliver and expand on volunteer programs for biodiversity and conservation outcomes. Public participation in the department's volunteer programs has improved communication, interaction and joint decision-making with different stakeholders.

CONSIDERATIONS FOR THE NEXT FMP

The department will seek to:

- continue, in a strategic manner, to revise and update guidance documents and policy where necessary.
- identify opportunities to increase knowledge of ecosystem health and vitality, climate change and carbon cycles.
- provide timely communication of scientific research to support decision making.
- maintain and enhance volunteer programs.
- build on existing educational programs to engage the community and raise public awareness.

3 Management Activities

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The end-of-term performance review provides a status for each of the 134 management activities in the FMP 2014-2023, as listed in Appendix 1. This provides a reporting metric as to the progress towards implementing the management activities during the FMP. Substantial progress was made and reported on in the mid-term performance review and this success continues to be built upon. The management activities reported upon confirm the success of FMP 2014-2023 and the progress that was made toward the CPC's goals in formulating the plan. These include:

- all activities to be undertaken in a manner taking account of the principles of ESFM;
- providing social, cultural and economic benefits valued by the community;
- conserving and maintaining biodiversity;
- sustaining the health and vitality of ecosystems;
- maintaining the productive capacity of ecosystems;
- protecting soil and water resources; and
- sustaining the contribution to global carbon cycles.

An increase in the number of management activities which were met rose from 56 per cent in 2017 to 61 per cent in 2021 (Table 15). The number of management activities that had not yet started, or had no progress, reduced from eight per cent in 2017 to four per cent in 2021.

Rating	2017	2021
Not achieved / no progress	20	13
Partly achieved / in progress	29	21
Substantially achieved / substantial progress	64	65
Achieved / completed	143	157
Total	**256**	**256**

Table 15. Summary of the management activities report card.

Sufficient resources are required to successfully undertake the management activities outlined in FMP 2014-2023. Some management activities remain ongoing, including liaison with other agencies and government departments and so will not be completed during the life of this plan.

4 Summary

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Using the available information, the end-of-term performance review has considered whether the department has met each of the 24 KPIs and assessed the status of 50 performance targets to indicate progress towards achieving the implementation of FMP 2014-2023.

Substantial progress towards implementation of FMP 2014-2023 was reported in the mid-term performance review, with 80 per cent of performance targets assessed as being achieved or largely met. This has increased to 82 per cent for this end-of-term performance review (Figure 26). Performance targets where there has been no progress remains consistent with the mid-term performance review at four per cent.

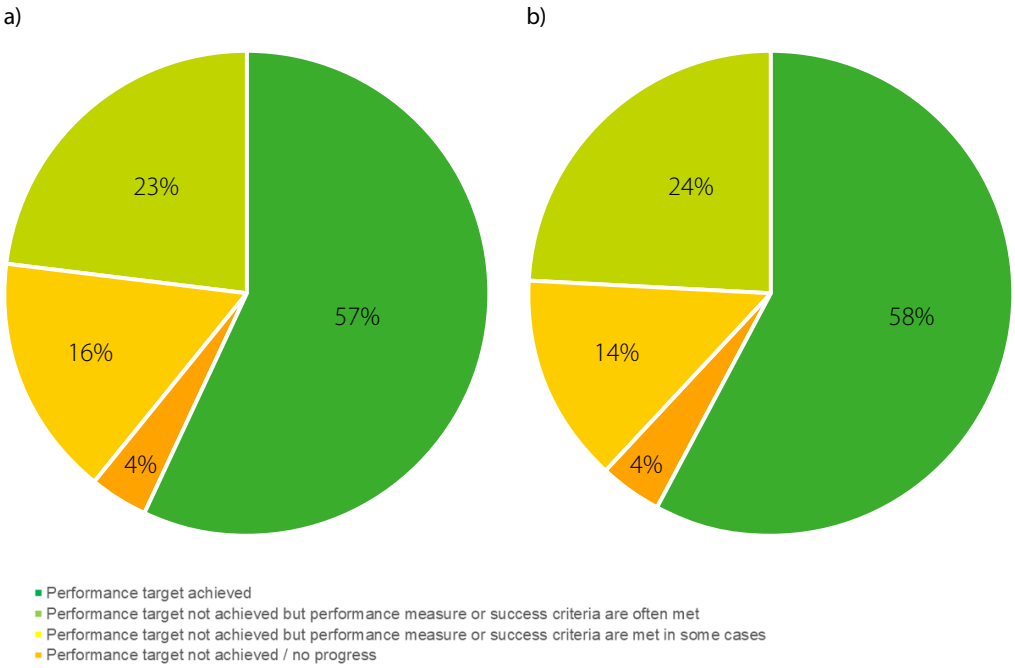

Figure 26. Overall level of achievement of the performance targets for FMP 2014-2023 for a) 2017, and b) 2021.

Areas of improvement have been identified in the whole of forest condition (KPI 1) and the establishment of local area arrangements and protocols for Aboriginal customary activities (KPI 22). Performance targets for the removal of log products compared to the allowable cut (KPI 16) were not reported against in the mid-term performance review. For the end-of-term performance review these performance targets have been achieved with a stable trend.

Limited progress has been made in two areas, specifically reserve creation (KPI 1) and knowledge of the amount of carbon stored in the forest (KPI 14).

The main reason for the performance targets not being met is the use of available resources on other high priority projects. Both reserve creation and carbon storage are expected to be addressed and have higher government priority during the preparation and implementation of FMP 2024-2033.

As outlined in the mid-term performance review, assessment of the performance targets for KPIs related to biological diversity and ecosystem health and vitality, required the use of surrogate information as the regional conservation plans had not been finalised. Substantial progress has been made on preparing the plans, with completion expected by late 2022. It is anticipated implementation of these plans will assist with progress reporting for FMP 2024-2033.

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Appendices

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Appendix 1 Management activities report card

Reporting metric	Rating and symbol	
Achievement / progress	Performance target not achieved / no progress	
	Performance target not achieved but performance measure or success criteria are met in some cases	
	Performance target not achieved but performance measure or success criteria are often met	
	Performance target achieved	
Direction of progress (compared to previous period)	Improved	↗
	Steady	—
	Decreased	↘
Confidence in rating (C)	Low	L
	Medium	M
	High	H

The report card below is interpreted in the context of the purpose of a CALM Act management plan which allowed management and disturbance activities to be undertaken when and where necessary across the FMP area. Not all management activities were undertaken during the reporting period of the FMP. Interpretation of the implementation of the management activities has been conducted considering the management activity being reviewed, including its intent, purpose, and desired outcome. For ease of understanding and brevity the full text of each management action is not repeated below. Interpretation of each management activity needs to be understood and interpreted using the full text in the FMP rather than the abbreviated one below. A breach of a management activity during the FMP period does not over-ride the final achievement of that management activity's overall rating. It should be noted that there was an intention to undertake all the listed management activities, however it was not always practicable and reasonable to do so. Activities where the responsibility was assigned to other agencies such as FPC, were assessed by those agencies.

Report card

No.	Management Activity (abbreviated)	Achievement				C
1	initiate and/or progress processes for land category changes			•		H
2	management consistent with proposed land category - NP, NR, CP				•	H
3	establishment of CAR reserve system outside RFA area				•	H
4	management consistent with proposed land category - FCA				•	H
5	conduct operations within informal reserves according to guidelines				•	H
6.1	publish a map each year showing old-growth forest and any changes				•	H
6.2	uniformity of approach for assessment of old-growth forest status				•	H
6.3	develop a procedure to identify and demarcate old-growth forest				•	H
7	commission maintain nominations and assessment until 6.3 completed				•	H
8.1	minimise permanent loss of native vegetation from development				•	M
8.2	offset losses arising from development in line with policy				•	M
8.3	infrastructure construction at common locations out of sensitive areas			•		H
9.1	liaise with departments of Mines, Industry Regulation & Safety and Jobs, Tourism, Science & Innovation				•	H
9.2	seek to minimise impact of mining and petroleum operations				•	H
9.3	provide advice on native ecosystems to minimise impacts				•	H
9.4	explore mechanisms to recover costs from proponents' operations			•		H
10	maintain lists of threatened & priority species & ecological communities				•	H
11	develop, review and implement recovery plans			•		H
12	use of Fauna Distribution Information System – harvesting and burning				•	H
13	approval of management activities within plantations			↗		H
14.1	maintain a broad range of forest ages, structures and composition				•	H
14.2	operations with regard to *Goals for Understorey Structural Diversity*				•	H
14.3	management strategies that promote adaption to climate changes			•		M
14.4	review the CAR system as necessary				•	H
15.1	reference requirements to protect key habitat in codes and guidelines				•	H
15.2	values recorded, accessible to staff & considered prior to operations				•	H
15.3	set conditions to protect biodiversity during permitted disturbance				•	M
15.4	promote awareness and understanding of the value of biodiversity				•	H
16	fire operation guidance to minimise loss of legacy habitat elements			•		H
17.1	revise *Guidelines for Selection of Fauna Habitat Zones*				•	H
17.2	finalise locations of Fauna Habitat Zones (FHZ)				•	H
17.3	publish a map each year depicting FHZ and identifying any changes				•	H
18	conduct operations in FHZ and indicative FHZ according to guidelines			•		H
19.1	conduct biological surveys of priority areas			•		H
19.2	use the surveys to review biodiversity conservation and CAR reserve			•		H
19.3	record surveys in relevant data bases accessible to other users				•	H
20.1	maintain Forestcheck monitoring program and seek to extend it				•	H
20.2	maintain a research program on ESFM				•	H
21.1	maintain competent & sufficient fire management capability				•	H
21.2	maintain fire science capability & work collaboratively with others			↗		H
21.3	consult on planning and implementation of prescribed burning				•	H
21.4	undertake annual prescribed burning program				•	H
21.5	undertake bushfire suppression operations according to guidelines				•	H
21.6	develop staff and contractor competency with environmental issues			•		H
22.1	FPC collaborate on bushfire risk mitigation strategies – timber				•	H
22.2	FPC provision of funding to control bushfire risk to acceptable levels				•	H
23.1	maintain surveillance and recording systems for significant weeds				•	H

No.	Management Activity (abbreviated)	Achievement				C
23.2	collaboratively identify priority weeds using risk based-procedures				•	H
23.3	collaboratively prepare incursion plans for weeds not yet present	—				H
23.4	identify relative importance of areas for protection and controls		↗			M
23.5	implement coordinated control programs for priority weeds		↗			M
24	maintain weed science capability and work collaboratively with others				•	H
25	FPC minimise risk that seedlings transport unwanted weeds to forest				•	H
26.1	FPC maintain surveillance and recording systems for priority weeds			•		H
26.2	FPC minimise spread & implement control programs for priority weeds			↗		H
26.3	FPC control spread of plantation species beyond boundaries				•	H
26.4	FPC minimise risk seedlings transport unwanted weeds				•	H
27.1	maintain surveillance and recording systems for pests		—			H
27.2	work collaboratively with others on priority pests			↗		H
27.3	prepare incursion management plans for priority pests not yet present		—			H
27.4	identify areas for protection & controls for pests already present		—			M
27.5	identify & protect individuals and populations that show resistance		—			M
27.6	encourage coordinated involvement in addressing pest species			↗		M
28	maintain *Western Shield* program				•	H
29	maintain pest science capability & work collaboratively with others				•	H
30	FPC minimise risk that seedlings could transport unwanted pests				•	H
31.1	Plantations – FPC maintain surveillance for priority pests				•	H
31.2	use operational controls to minimise risk of introduction and spread				•	H
31.3	identify and protect individuals and populations that show resistance		•			H
31.4	minimise risk that seedlings could transport unwanted pests				•	H
32.1	surveillance & recording systems for forest diseases & syndromes		—			M
32.2	work collaboratively with other agencies to determine priorities		—			M
32.3	prepare incursion management plans for disease not yet present		↗			H
32.4	identify priority areas for protections & operational controls		↗			H
32.5	identify and protect individuals and populations with resistance	—				H
32.6	encourage coordinated involvement in awareness and implementation			•		M
32.7	training & accreditation for consistent implementation – *Phytophthora*			↗		H
33	maintain diseases & syndromes science capability & work with others		—			H
34	FPC minimise risk that seedlings transport unwanted pathogens				•	H
35.1	Plantations – FPC maintain surveillance and recording systems				•	H
35.2	minimise risk of introduction and implement control programs				•	H
35.3	identify and protect individuals and populations with resistance		↗			H
35.4	minimise risk that seedlings transport unwanted pathogens				•	H
36.1	Mining - agreed rehabilitation & completion standards			•		H
36.2	verification that rehabilitation meets agreed completion criteria			•		H
36.3	explore performance bonds refundable on satisfactory handback			•		H
37.1	use natural regeneration where reasonable and practicable, or…				•	M
37.2	use genetics & traits to inform choice of areas for seed collection				•	H
37.3	where 37.2 not possible use seed from same or adjacent LMU			•		L
37.4	otherwise on approval use other seed sources including mixed sources	Not applicable				
38	report to Conservation Commission where other seed sources used			•		L
39	good practice applied to mining rehabilitation			—		M
40.1	develop guidelines for ongoing management of mine site rehabilitation			—		H
40.2	management intervention on mine site rehabilitation – changing climate			—		H
40.3	adaptive management approach to mine site rehabilitation			•		H
41	conduct operations involving heavy vehicles according to guidelines				•	H

No.	Management Activity (abbreviated)	Achievement	C
42	revise documents - rehabilitation for extraction tracks, landings & roads	—	H
43	revise fire management documents – measures to minimise erosion	·	H
44	documents and training to address containment of spills	·	H
45.1	FPC Plantation operations give regard to guidelines for soil protection	·	H
45.2	FPC Plantations – rehabilitate damaged soil resulting from operations	·	H
46	operations in accordance with silvic, FHZ & soil and water guidelines	·	H
47	Department undertake or approve silviculture for ecosystem health	Not applicable	
48.1	treatment parameters for silviculture for water production proposals	Not applicable	
48.2	catchment management plans for silviculture for water production	Not applicable	
49	commission develop position statement on proposals to take water	·	H
50.1	advice & assistance – access to sub-surface and surface water	·	M
50.2	facilitate access to land for water extraction & associated infrastructure	·	M
50.3	Department will take and use water sustainably	·	M
50.4	may issue permits after consultation for the sustainable taking of water	·	H
51	apply phased harvesting requirements for salt sensitivity	·	H
52	planning to avoid salt risk in partially cleared catchments	·	H
53	FPC plantation operations conducted with regard to water protection	·	H
54	FPC plantations prepare catchment management plans if required	Not applicable	
55.1	knowledge on climate change impacts on ecosystems and yield	·	H
55.2	identify climate-impact refugia and implement strategies to maintain	·	H
55.3	maintain forest carbon science capability and work collaboratively	↘	H
55.4	report on carbon stores in the next draft FMP	Not yet due	
55.5	incorporate climate change into future planning & management	·	H
55.6	contribute to State & national policy development adaption & mitigation	↗	M
55.7	investigate opportunities from an emerging carbon economy	↗	M
55.8	review guidelines to incorporate recognition of global carbon cycles	—	M
56.1	FPC Plantations remain abreast of knowledge on possible impacts	·	M
56.2	encourage use of wood to maximise greenhouse mitigation benefits	—	M
57.1	minimise permanent loss of forest available for wood production	·	H
57.2	seek to replace native forest and plantation lost to development	·	H
57.3	promote construction of infrastructure at common locations	·	H
58	FPC Plantations meet State Agreement Act by replanting pines	·	H
59	FPC may replant clear-felled hardwood plantation to softwood	·	H
60	logs removed must not exceed 10 times annual average allowable cut	·	H
61	FPC may enter into contracts in addition to 60 above if approved	Not applicable	
62	FPC will prepare a timber industry development strategy	·	H
63	sale of other species forest products is permitted where approved	·	H
64.1	Department prepare rolling 3 yr indicative plans in consultation - FPC	·	H
64.2	consistent with allowable cut & volumes contracted by FPC	·	H
64.3	approved by the Department	·	H
64.4	made publicly available	·	H
65.1	FPC prepare annual timber harvesting plans approved by Department	·	H
65.2	consistent with allowable cut and volumes contracted	·	H
65.3	made publicly available	·	H
65.4	varied at a coupe location or boundary level with prior approval	·	H
66.1	FPC prepare coupe level plans consistent with 65 above	·	H
66.2	sufficient information to enable evaluation of prosed operations	·	H
66.3	approved by Department prior to disturbance operations commencing	·	H

No.	Management Activity (abbreviated)	Achievement				C
67.1	FPC and Department monitor quantity of all log products removed				•	H
67.2	periodically monitor the grading and removal of sawlogs			•		H
68	FPC monitor and record areas of each different silvicultural treatment				•	H
69	Department maintain a process to verify 68 above				•	H
70	FPC provide suitable information - other than 1st or 2nd grade sawlog			•		H
71	Department may use forest produce that becomes available				•	H
72	Department refine data and methods for sustained yield calculation			•		H
73.1	facilitate recovery of forest produce from other management activities				•	H
73.2	determine if wood from salvage harvest counts toward allowable cut				•	H
73.3	Develop guidance document - planning & approval of salvage harvest				•	H
74	Plantations FPC optimise yield & (where not inconsistent) other values			↗		H
75	Plantations FPC prepare annual timber harvesting plans			↗		H
76.1	Plantations FPC prepare compartment level plans consistent with 75				•	H
76.2	provide sufficient information for Department to evaluate				•	H
76.3	approved by Department prior to disturbance operations commencing				•	H
77	Plantations FPC monitor volume of all log categories removed annually				•	H
78	Plantations FPC operations in accordance with silvicultural guidelines				•	H
79	Plantations FPC record areas of silvicultural treatments each year				•	H
80	Plantations FPC refine data and methodology for yield calculations				•	H
81.1	Plantations FPC replant clearfelled areas (consistent with policy)				•	H
81.2	rehabilitate clearfelled plantation not to remain as plantation	—				H
82	Plantations FPC maintain breeding programs to achieve outcomes				•	H
83.1	Other Exotics - programs with a view to future rehabilitation to natives			•		H
83.2	assess before silvicultural or other treatments to determine if required			•		H
83.3	undertake or reschedule treatment (83.2) according to assessment			•		H
84	Other Exotics – monitor and record treatment areas each year			•		H
85	Department may seek proposals to facilitate rehabilitation to natives			•		H
86.1	Department regulate supply of other forest produce through licensing				•	H
86.2	maintain & prepare guidelines for management of other forest produce				•	H
86.3	monitor supply patterns for signs of non-sustainability			•		H
86.4	implement trials in selected areas for supply of public firewood		—			M
86.5	facilitate salvage of other forest produce where appropriate				•	H
87	FPC make wood available to small processors and craftwood artisans				•	H
88	FPC conduct native forest regeneration according to guidelines			•		H
89.1	FPC undertake native forest regeneration using natural regeneration				•	H
89.2	where 89.1 not practicable - using genetic and life history traits				•	H
89.3	where 89.2 not available - using material from same or adjacent LMU				•	H
89.4	otherwise using other or mixed sources subject to approval				•	H
90	Department and FPC report to Commission for 89.2 & 89.3				•	H
91	FPC develop markets for log grades which are currently under utilised			↗		H
92.1	FPC develop silvicultural treatment programs to promote sawlogs				•	H
92.2	assess stand development to determine whether treatments required	↗				H
92.3	undertake or reschedule treatments according to 92.2 and markets	↗				H
93.1	prevent adverse effects on Noongar culture & heritage by consulting				•	H
93.2	facilitate access for Noongar customary purposes				•	H
93.3	community consultation, involvement in decision making & surveys				•	H
93.4	ensure compliance with provisions of the Aboriginal Heritage Act				•	H
94	work with appropriate groups joint management & customary activities			•		H

No.	Management Activity (abbreviated)	Achievement				C
95	facilitate cross-cultural awareness and interpretive activities				•	H
96	in consultation, assess importance of Noongar culture & heritage		↗			H
97.1	develop guidance for management of other Australian cultural heritage		—			M
97.2	presence & type of heritage places recorded, accessible & considered			↗		H
97.3	set conditions to protect heritage places during disturbance activities			↗		H
97.4	awareness & understanding - staff proponents operators & visitors			↗		H
98.1	conduct operations with regard to approved heritage guidance				•	H
98.2	co-operate with commonwealth, State agencies and others			•		M
99	processes that may result in reduced land base or restricted access				•	H
100	product mix that seeks to support a viable forest products industry				•	H
101.1	maintain understanding of visitor and recreation demand			•		M
101.2	support & plan for recreation & tourism & provide appropriate facilities				•	H
101.3	consider additional areas for off-road vehicle use in consultation				•	H
101.4	provide for the expansion of camping & caravanning facilities				•	H
101.5	work with water agencies to plan activities in water catchment areas				•	H
101.6	monitor & manage visitor use including regulating & licensing				•	H
101.7	seek to enrich visitor experiences & develop lifelong connections				•	H
102	reduce effects of development proposals on visual landscape quality			•		M
103.1	maintain & implement visual landscape classification & management			•		M
103.2	review and implement guidelines for visual landscape management			•		M
104	Plantations FPC consider impact of plantations of visual quality			•		M
105	review strategic access network with relevant stakeholders				•	H
106	seek resources to fund essential access infrastructure				•	H
107	retain develop & maintain strategic access for multiple needs			↗		M
108	design, construction and maintenance for unsealed roads - guidelines				•	H
109.1	BRM removals – comply with legislation, policy & guidelines - review			•		M
109.2	contribute to government strategies including *State Gravel Supply*			•		H
109.3	where practicable sourced from a network of (fewer) strategic pits			•		M
110	certified returns for BRM removals by government agency or LGA		•			M
111	management guidelines for sterilised BRM			↗		H
112	database for BRM extraction & works programs for rehabilitation		↘			H
113.1	Provide advice on BRM proposals – timely rehabilitation of all pits				•	H
113.2	cost of rehabilitation is borne by the organisation responsible			•		M
114	issue & administer leases and licenses for facilities, activities & uses				•	H
115	encourage development of Noongar enterprises within the plan area				•	H
116.1	administer agreements with bioprospecting companies				•	H
116.2	contribute to the development of modern bioprospecting legislation				•	H
117	planning checklist for disturbance activities - sufficient information			•		M
118.1	prepare a regulation policy for timber harvesting				•	H
118.2	develop & implement formal working arrangements				•	H
119	common training and accreditation programs for staff and contractors				•	H
120	prepare and / or revise subsidiary documents				•	H
121	develop a protocol for each key performance indicator				•	H
122	cooperate with Commonwealth – Montreal Indicators Program				•	H
123	conduct audits considering risk to achievement of FMP goals				•	H
124	report & publish audit results			•		H
125	FPC report audit results to Department & Commission & publish			•		H
126.1	address knowledge gaps including through benchmarking & research				•	H

No.	Management Activity (abbreviated)	Achievement				C
126.2	work collaboratively with other agencies & institutions				•	M
126.3	transfer of new knowledge into improved management & operations				•	H
126.4	conduct and prepare policy on adaptive management				•	H
127	Plantations FPC – undertake audits and report				•	H
128.1	evaluate performance & determine if FMP should be amended				•	H
128.2	amend plan if required according to the CALM Act				•	H
128.3	take action to address problems identified in management systems				•	H
129	initiate an expert review of silvicultural practices (2nd half of this plan)				•	H
130	undertake mid-term & end-of-term performance reviews				•	H
131	where performance targets not achieved investigate cause and report				•	H
132.1	Commission evaluate the need for revision of management practices				•	H
132.2	provide advice through mid-term & end-of-term reviews to Minister				•	H
133	undertake public consultation - management policies & guidelines		↘			M
134.1	provide community with educational opportunities &information				•	H
134.2	maintain public consultation processes				•	H
134.3	provide opportunities for community participation				•	H

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