



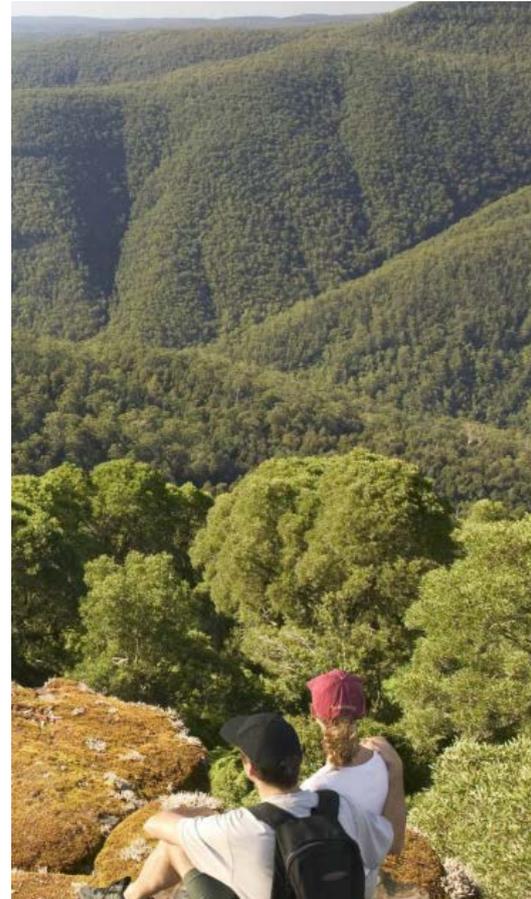
Natural Resources Commission

NSW Forest Monitoring and Improvement Program

“Delivering the evidence we need, for the forests we want”

Annual Progress Report

July 2022



This document has been prepared by the NSW Natural Resources Commission on behalf of the **NSW Forest Monitoring Steering Committee**.



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Acknowledgement of Country

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

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Acronyms

DPE	Department of Planning and Environment
DPI	Department of Primary Industries
EPA	Environment Protection Authority
FCNSW	Forestry Corporation of NSW
FMIP	Forest Monitoring and Improvement Program
IFOA	Integrated Forestry Operations Approval
NPWS	National Parks and Wildlife Service
NSW	New South Wales
SEED	Sharing and Enabling Environmental Data

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Executive summary

The Forest Monitoring and Improvement Program (the program) delivers information to support the strategic management of forests in NSW across national parks, state forests, other crown land, private land and Aboriginal land. It is overseen by the NSW Forest Monitoring Steering Committee (the Committee), independently chaired by the Commission.

This third annual progress report summarises program achievements and insights for 2021-22. There is a separate annual report outlining progress under the Coastal Integrated Forestry Operations Approval (IFOA) monitoring program. In addition, the Commission will publish a report synthesising findings to date across both monitoring programs.

Funding for coordinated, cross-tenure forest monitoring under this program ends in June 2022. Nearly all of the program's deliverables have been met, with a few remaining projects due for completion in the coming months. The information generated by the program has provided new knowledge about how to best manage NSW forests for our communities, industries and flora and fauna, and established a foundation for future monitoring and evaluation. However, as with any natural resource monitoring, the value and return on the excellent work to date will increase over time with an ongoing commitment to long term monitoring.

Wildfire has impacted forest condition and carbon balance

Overall forest extent increased by nearly 1.3 million hectares (7.1 percent) across NSW between 1998 and 2018, remaining relative stable across national parks and state forests and with most increases on private land. However, NSW coastal forests were significantly impacted by the 2019-20 wildfires, which disproportionately affected national parks and state forests compared with forests on private land. Overall, the post-fire forest canopy extent in 2020 was around 5 percent (102,534) lower on state forests and 6.7 percent (358,974) lower on national parks compared with the 1998 baseline.

As a result of the 2019-20 wildfires, there was a large increase in forested areas shifting to the 'vulnerable' and 'too frequently burnt' categories that indicate a risk of decline in plant diversity, with the largest shifts occurring on state forests. Up to 90 million tonnes of carbon from NSW forest biomass was released to the atmosphere because of the wildfires. This is equivalent to 330 million tonnes of carbon dioxide, resulting in the largest change in forest carbon in NSW than at any other point in the preceding three decades. Research also found wildfires have a major influence on soil organic carbon concentrations and more frequent wildfires may result in progressive decline in soil health.

NSW biodiversity is under threat from future fires

Climate change and fire represent the most significant threat to biodiversity based on the largest and most significant study of its type in the history of NSW forest management. Occupancy modelling for 54 of the 78 fauna species analysed predicted these species would become less abundant by 2070, including the Powerful Owl and the Greater Glider.

Koala density was most impacted in areas that experienced medium to high severity wildfire over the 2019/20 summer. Koalas were temporarily absent in these areas, but localised recovery was evident after a year. At the regional scale, there was no overall decline in post-fire koala occupancy detected. However, future fires may lead to more significant adverse effects on habitat quality, connectivity and refuge areas for koalas.

Water flows are declining in forested catchments

Annual water flows have decreased in forested catchments in coastal NSW over the last 35 years, particularly in south coast forests, with 10 to 20 percent flow decreases relative to long-term averages in one third of coastal forest catchments. Nearly half of the inland catchments showed similar results, with water flows decreasing by around 10 to 25 percent relative to mean

annual flows in nearly half of the catchments analysed. Between 2001 and 2021, fire events had some influences on the quantity of streamflow, but the impacts are generally smaller than the effect of coincident changes in climatic drivers.

Researchers also analysed water quality data, which showed mixed trends that varied between indicators. However, limited long-term monitoring sites and data for water quality indicators prevented the identification of large-scale trend patterns.

Aboriginal participation needs to increase

Aboriginal-led assessments found many cultural values were destroyed or at higher risk due to the impact of the 2019/20 wildfires. Aboriginal people are concerned that cultural sites will be deregistered or devalued where tangible cultural values are damaged or lost. More broadly, there are significant knowledge gaps around Aboriginal cultural values both pre- and post-fire. The program has facilitated new and stronger partnerships between Aboriginal people, NSW public land management agencies and private landholders. There is strong desire to build on outcomes achieved under the program to strengthen Aboriginal peoples' participation in management and decision making.

Environmental and economic data gaps exist for forest management and values

The NSW Government established the program in response to community demand for relevant and reliable information on the health of forest ecosystems and the community values they support. The program commissioned leading scientists to analyse state and national datasets to establish historical baselines and trends for forest ecosystems. The outputs of this work are reported in this paper and are recognised as some of the most significant assessments ever undertaken in NSW.

However, large data gaps remain, and will continue to compromise our understanding of forest health and values unless there is a coordinated long-term monitoring and research program. For example, there are few large-scale, long-term monitoring programs to establish reliable trends in species occupancy from field data alone. In the last decade, less than 50 soil carbon measurements have been collected across the entire NSW Regional Forest Agreement regions. Reliable results for water quality in forested catchments could not be determined due to poor data coverage. Establishing reliable data on forest-dependent jobs will also need further engagement and support from industry and NSW agencies.

The program will now focus on monitoring in production forests

With funding for cross-tenure monitoring under the program ceasing in June 2022, the Committee will focus on monitoring in production forests under existing and new mandates that require monitoring and evaluation for the Coastal IFOA and the Private Native Forestry (PNF) Codes respectively.

The Environment Protection Authority provided \$2 million from 2019-20 for the initial design and implementation of the Coastal IFOA monitoring program, supported by in-kind contributions from Forestry Corporation of NSW. However, funding for this program will cease in FY 2023. Local Land Services are providing over \$1.5 million over two years (FYs 2023 and 2024) to commence a PNF monitoring, evaluation and reporting program. The Committee is overseeing initial planning and priority activities. This is a welcome start but needs to be extended long term given the trajectories of change in our forests, particularly in light of climate change. Further, a similar quantum and long-term funding commitment is required for monitoring on state forests from the end of FY 2023 onwards.

The Commission, on behalf of the Committee, will work with relevant agencies to develop a further business case for future monitoring on productive forests for Government consideration. If successful, this will ensure the NSW Government has the necessary evidence to support its commitments under the NSW Forestry Industry Roadmap and the NSW Regional Forest Agreements, and to build community understanding and trust that it is meeting its broader obligations for ecologically sustainable forest management.

1 Introduction

In 2019, the NSW Government established the Forest Monitoring and Improvement Program (the program) to support ecologically sustainable management of all NSW forests. The Premier asked the Natural Resources Commission (the Commission) to independently oversee the program, which is to be collaboratively undertaken by NSW agencies working with universities, private sector scientists, the community and industry.

The program delivers information to support the strategic management of forests in NSW on both public and private land. Under the program's terms of reference, all forests in NSW are within scope, including forests in national parks, state forests, plantation forests, private native forestry, forests on private and Crown land.

The Commission independently chairs the NSW Forest Monitoring Steering Committee (the Committee). The Committee consists of NSW agencies with responsibilities for natural resource and environmental policy, regulation, and science, as well as agencies with a direct role in the management of forested lands. The Commission has appointed five independent experts with expertise in biodiversity, forestry, soil and water, Aboriginal natural resource management and social sciences to advise the Committee.

The Committee is tasked with ensuring the program delivers open and transparent information in a timely manner, and that commitments are tracked and delivered. This third annual progress report fulfils this requirement in 2021-22 by setting out program achievements, insights and opportunities, and priority next steps for the year ahead.

1.1 The program has delivered outcomes

The Committee commissioned an independent evaluation of program outcomes and delivery to date in line with the [program evaluation plan](#).

Overall, the [evaluation report](#) found the program had taken an important step to significantly improve the information base available in NSW to sustainably manage forests. The program has commissioned more than a dozen projects that have collated, analysed and reported on different forest values, trends and management practices. Large amounts of previously difficult to access historical data have been located, collated and integrated to establish baseline conditions for a range of forest values.

In addition, the program has ensured that this data and findings are released publicly so they are accessible by the community, researchers, business and industry.

The evaluation found the program was delivered with a clear focus on providing cost effective outcomes including trialling new technologies, using historical data and aligning work across agencies. Outputs from the program are varied and offer value as individual projects. However, there is a need to draw them together into a cohesive set of insights and implications for forest management.

The program has also facilitated productive collaboration between agencies, including more consistent and coordinated monitoring of forest health. This has been achieved despite the agencies having different policy objectives and drivers and there being a tendency for agencies to conduct separate monitoring and research focused on their own priorities and requirements. The Commission's role as an 'honest broker' among agencies was critical to achieve this outcome. However, cross tenure monitoring is not continuing, as the National Parks and Wildlife Service has commissioned and established their own monitoring programs on the reserve system.

The evaluation suggested a range of recommendations, including developing an insights summary report and actively fostering continued connections across agencies.

1.2 Next steps for the program

The NSW committed over \$7 million to the program over four years (FYs 2019 to 2022). A business case to secure further funding was not successful. Funding for the broader cross-tenure program will cease in FY 2022. The Committee will finalise projects funded under the program in FY 2023.

The Committee will continue to oversee its monitoring and reporting obligations for the:

- **Coastal Integrated Forestry Operations Approval (Coastal IOFA)** – as prescribed under Chapter 8 of the Coastal IOFA conditions
- **Private Native Forestry Codes of Practice (PNF Codes)** – as prescribed in under section 4.3 of the PNF Codes.

2 Program highlights and achievements

2.1 Baseline and trends

2.1.1 Forest extent and health

Spatial Vision and the NSW DPI Forest Science Unit led a consortium including RMIT University, University of New England, PF Olsen, University of NSW, Forestry Corporation of NSW (FCNSW) and the NSW Department of Planning and Environment (DPE) to deliver baselines, drivers and trends for forest extent and condition across all tenures in NSW, including areas where historical forestry operations have occurred.

The [work found](#) that overall forest extent¹ increased across NSW between 1998 and 2018 by nearly 1.3 million hectares (7.1 percent), most of which occurred on private land while forested extent on public land remained largely stable with minor increases (**Figure 1, Table 1**).

However, the 2019-20 fires caused a significant reduction in forest canopy cover, disproportionately affecting national parks and state forests compared with forests on private land, particularly in coastal areas of NSW. After the fires, forest canopy decreased by 129,757 hectares across state forests and 438,132 hectares across national parks compared with 2018 values, with likely flow on effects on forest condition.

Overall, forest extent was around 5 percent (102,534) lower on state forests and 6.7 percent (358,974) lower on national parks post-fire in 2020 compared with the 1998 baseline. In contrast, forest canopy extent increased on private land in this period by 14 percent (963,774 hectares), with no loss of forest canopy extent observed following the 2019-20 fires.

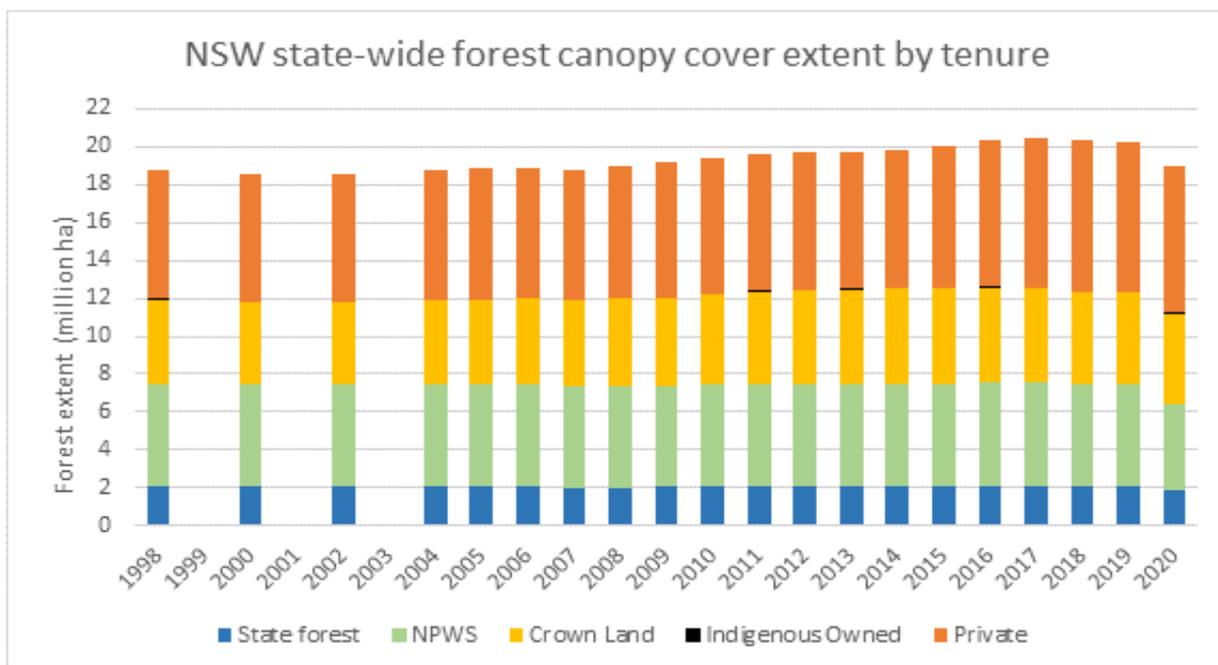


Figure 1: Forest extent by tenure across NSW²

¹ Defined in accordance with the National State of the Forests Report, which defines forests as 'containing as a minimum, a mature or potentially mature stand height exceeding 2 metres, stands dominated by trees usually having a single stem, where the mature or potentially mature stand component comprises 20 percent canopy coverage using a Crown Projective Cover measure'.

² Spatial Vision (2022). *Forest Monitoring – Extent, Condition and Health – Overview Report*, unpublished report to the Natural Resources Commission

Table 1: Average forest canopy cover extent (hectares) by major tenure for 5-year reporting periods³

Tenure	1998	2003	2008	2013	2018	2020	Percentage Change 1998-2018	Percentage Change 1998-2020
National Park	5,376,638	5,374,792	5,359,105	5,404,604	5,455,796	5,017,664	1.47%	-6.68%
State forest	2,042,774	2,047,139	2,044,688	2,039,787	2,069,997	1,940,240	1.33%	-5.02%
Indigenous Owned	28,532	28,481	29,770	31,114	30,473	30,788	6.80%	7.91%
Crown Land - Leasehold	4,093,695	3,927,853	4,066,608	4,364,246	4,438,220	4,267,593	8.42%	4.25%
Crown Land - Other	456,812	450,668	463,400	488,796	517,269	519,638	13.23%	13.75%
Private	6,871,751	6,731,287	6,885,583	7,198,779	7,695,587	7,835,525	11.99%	14.03%
Total	18,870,204	18,560,219	18,849,154	19,527,325	20,207,342	19,611,446	7.09%	3.93%

2.1.2 Species occupancy and distribution

The University of New England, Macquarie University and the NSW Department of Primary Industries (DPI) Forest Science Unit and the NSW DPE delivered their [final report](#) on baselines for selected fauna species across the NSW Regional Forest Agreement regions.

The project collated and synthesised a range of data and spatial, temporal and analytical techniques (including historical baseline data collation, species occupancy and environmental niche modelling, forecasting, survey gap analysis and power analysis) to establish baselines and context for future cross-tenure forest monitoring programs.

Occupancy modelling was undertaken for 28 priority fauna species across the north-east NSW region using data from systematic repeat surveys in the 1990s. Occupancy modelling was also undertaken separately for 16 priority species in the combined southern region (Southern and Eden). By undertaking occupancy modelling for the status of priority species in the late 1990s, the program has set a foundation for future monitoring to monitor the impact of different environmental factors on forest biodiversity.

In relation to harvesting activities on state forests, researchers found that few plant species have been adversely impacted by native timber harvesting, although many species were recorded too infrequently for rigorous analysis. Nine rainforest and wet sclerophyll forest species were identified as likely to be sensitive to timber harvesting (noting harvesting is excluded in mapped rainforest under the Coastal IFOA and PNF Codes).

Looking forward, the researchers found that that the combined effects of climate change and fire represent the most significant threat to biodiversity in eastern NSW forests. Identifying and implementing appropriate fire regimes and mapping the shifting mosaic of fires across the forest estate to conserve biodiversity remains a major challenge. Climate projections suggest that potential occupancy of 54 of the 78 assessed fauna species will decline by 2070, including the Powerful Owl and the Greater Glider.

³Spatial Vision (2022). *Forest Monitoring – Extent, Condition and Health – Overview Report*, unpublished report to the Natural Resources Commission

2.1.3 Forest water catchments

The University of Melbourne has developed baselines, drivers and trends for water quantity in the NSW Regional Forest Agreement areas. This research looked at forests across all tenures within the three NSW Regional Forest Agreement areas, which cover the Eden, North East and Southern NSW regions.

The researchers have delivered a [final report](#) which found:

- annual flows have decreased in forested catchments over the last 35 years (**Figure 2**), with most significant decreases in south coast forests (**Figure 3**)
- one third of coastal forest catchments had 10 to 20 percent flow decreases relative to long-term averages
- flow reductions were generally smaller for catchments with higher mean annual flow, greater area of national park, greater accumulated area harvested, or greater accumulated area burnt
- a lack of adequate available data led to mixed and inconclusive results across water quality indicators.

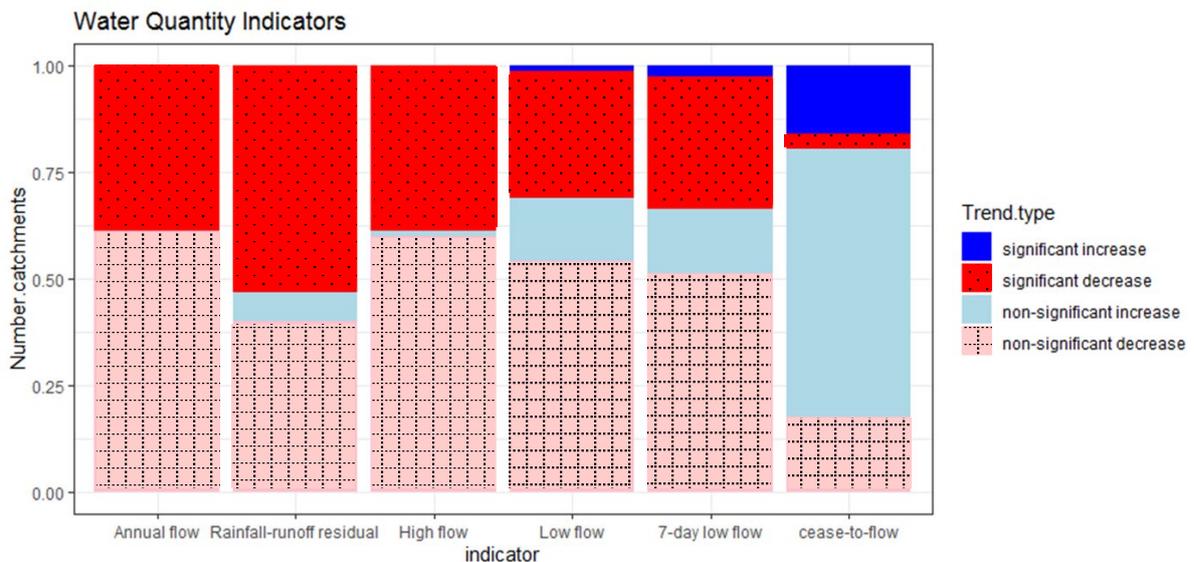


Figure 2: Proportion of forested catchments analysed that has shown each type of long-term trend for water quantity indicators: significant increase, significant decrease, non-significant increase or non-significant decrease⁴

⁴ Guo, D., Hou, X., Saft, M., Webb, J.A., Western, A.W. (2010) *Report for NRC Forest Baseline & Trend Indicators - Project 3 Task 2 - Long-term trends of Water Quality and Quantity in NSW RFA forests*. University of Melbourne.

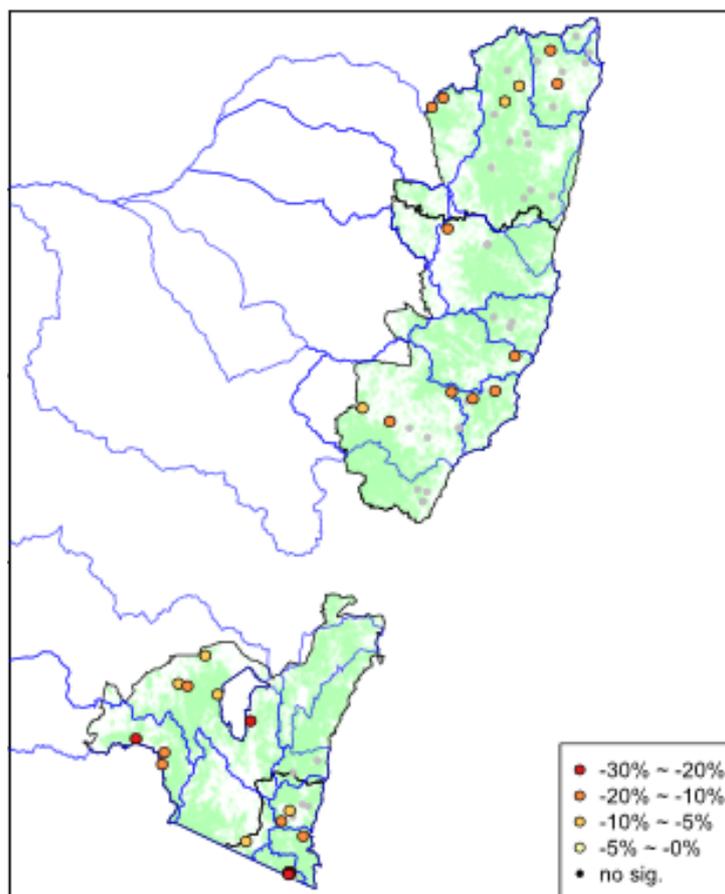


Figure 3: Magnitude of long-term trends in mean annual flow at assessment sites across forested catchments within the RFA region of NSW - all trend magnitudes are in percentage change per decade, relative to the long-term averages of individual sites⁵

The University of Melbourne team was also commissioned to carry out further work:

- extending the analysis to other forested catchments in NSW, and applying novel statistical approaches to identify the flow responses to climate variability, and thus to clearly identify any impact of catchment disturbance and forest management
- analysing post-fire data to assess the water quality and quantity impacts of the 2019-20 wildfires in the coastal region.

This additional work is largely completed, with researchers reporting the following findings:

- as in the original research, there are large-scale declining flow trends in study areas outside of the Regional Forest Agreement region, with 42 of the 90 catchments analysed showing statistically significant decreases
- for catchments with significant flow decreases, the magnitudes of decline are mostly 10 to 25 percent per decade relative to the mean annual flow of the catchment
- the water quality indicators showed mixed trends which varied between indicators, with limited long-term monitoring sites and data for these indicators again preventing the identification of large-scale trend patterns
- there is little evidence that the 2019-20 wildfire had a substantial impact on streamflow at the catchment scale compared with long-term historical conditions, with changes in flow generally driven by hydro-climatic factors

⁵ *Ibid.*

- the impact on of the 2019-20 wildfire on water quality is highly case specific and controlled by hydrological condition and the timing of post-fire rainfall/flow events.

The two projects both indicate declining water quantity over NSW driven by hydro-climatic factors, which has significant implications for future water security for NSW. In particular these findings highlight the need to consider potential responses to changing climate conditions in future.

Final reports are expected to be released in mid-2022 on the [Commission's website](#) and the data made publicly available.

2.1.4 Soil stability and health in forest catchments

A consortium between the NSW DPE and the University of Sydney has delivered baselines, drivers and trends for soil stability and health in forest catchments across the NSW Regional Forest Agreement areas.

The researchers have delivered a [final report](#) which found:

- modelling reveals soil organic carbon has declined slightly over the last three decades, although significant fluctuations occurred in this period likely driven by climatic conditions (**Figure 4**)
- climate change is predicted to contribute to a decline in soil organic carbon condition over most of the area covered by the NSW Regional Forest Agreements, particularly the southern alps (**Figure 5**)
- areas subject to increased ground disturbance from land use activity (particularly in forests in which grazing is permitted) have lower concentrations of soil organic carbon than less disturbed areas
- wildfires have a major influence on soil organic carbon concentrations, and more frequent wildfires expected as a result of climate change may result in continuing decline of soil health.

The researchers reported critical data gaps relating to soil health due to a lack of sustained monitoring. They recommended that a long-term soil health monitoring program is needed to support management of forest soils. In addition, the researchers suggested forest managers should implement appropriate soil carbon-enhancing strategies to at least maintain current levels, if not increase them, to assist in meeting net carbon emission targets, mitigate climate change and improve forest health.

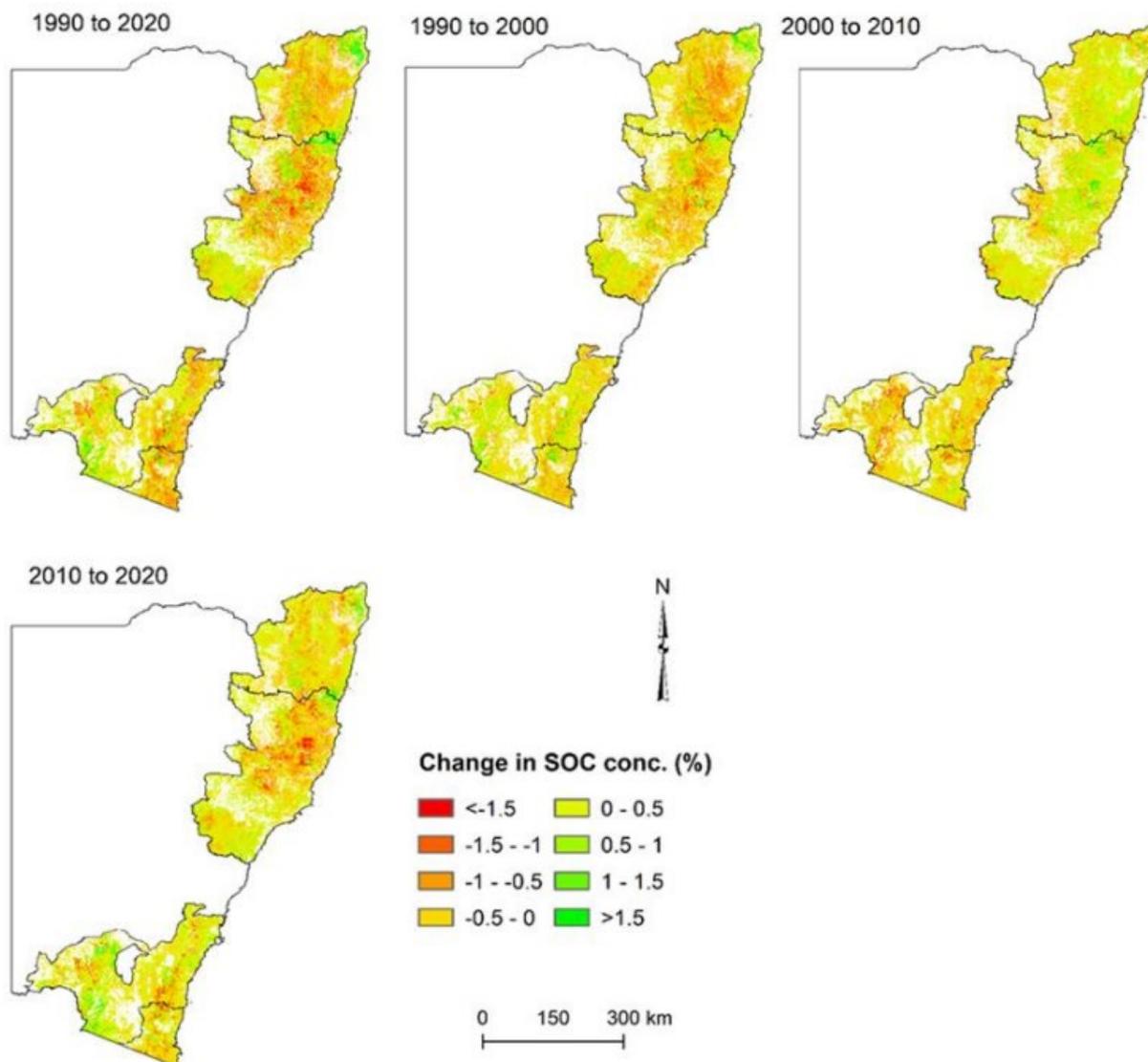


Figure 4: Estimated change in surface soil organic carbon (SOC) concentrations (%) across Regional Forest Agreement regions between four time steps, 1990-2020⁶

⁶ Moyce MC, Gray JM, Wilson BR, Jenkins BR, Young MA, Ugbaje SU, Bishop TFA, Yang X, Henderson LE, Milford HB, Tulau MJ, (2021). *Determining baselines, drivers and trends of soil health and stability in New South Wales forests: NSW Forest Monitoring & Improvement Program, Final report v1.1* for NSW Natural Resources Commission by NSW Department of Planning, Industry and Environment and University of Sydney.

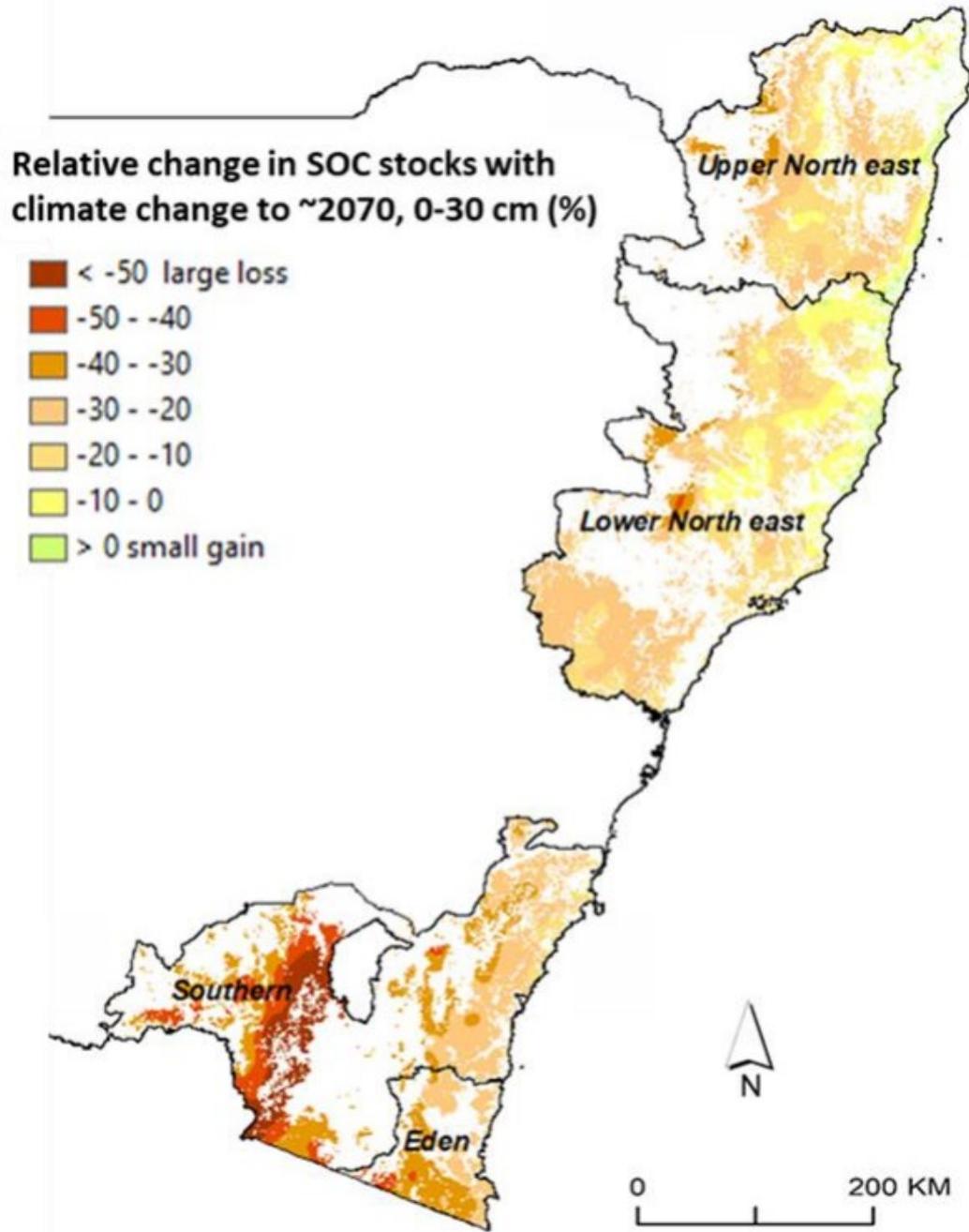


Figure 5: Predicted relative change (%) in surface soil organic carbon (SOC) concentrations with projected climate change to approx. 2070⁷

⁷ Moyce MC, Gray JM, Wilson BR, Jenkins BR, Young MA, Ugbaje SU, Bishop TFA, Yang X, Henderson LE, Milford HB, Tulau MJ, (2021). *Determining baselines, drivers and trends of soil health and stability in New South Wales forests: NSW Forest Monitoring & Improvement Program, Final report v1.1* for NSW Natural Resources Commission by NSW Department of Planning, Industry and Environment and University of Sydney.

2.1.5 Carbon balance of NSW forests

A team from the Mullion Group, NSW DPI and the CSIRO have quantified the carbon balance of NSW forests and how this may change under different policy, management and climate scenarios. The work was led by Dr Robert Waterworth, a lead Intergovernmental Panel on Climate Change author and former Eureka science prize winner.

The researchers have delivered a [final report](#) that found:

- there has been a net loss of forest carbon within NSW between 1990 and the end of 2020, estimated at around 164 million tonnes of carbon (excluding soil) using a 'mid' growth scenario model (**Figure 6**) – for reference, this is the same mass as the annual greenhouse gas emissions from the electricity sector in Australia for 2020-21⁸
- the net loss is primarily driven by the 2019/2020 fire season, which resulted in significantly larger changes in forest carbon than at any other point in the preceding three decades
- there was a general decline in forest carbon in the 1990s, net gains in forest carbon from the mid-2000s to 2019, and a large loss of forest carbon in 2020 associated with fire events.

The authors note this project demonstrates importance of having a comprehensive forest monitoring program in place with operational systems to conduct relevant analyses.

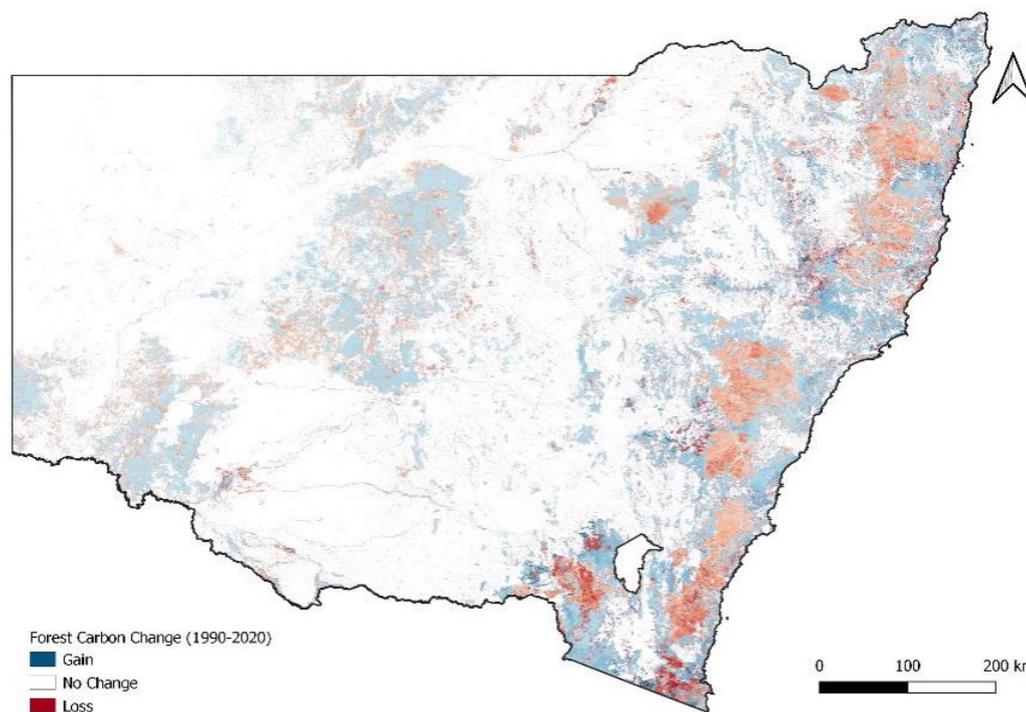


Figure 6: Spatial Output of change in forest carbon within NSW between 1990 and 2020, including Aboveground Biomass, Belowground Biomass, and Dead Organic Matter. Harvested Wood Products in use is not included in the spatial aggregation. Soil carbon was excluded from the results. Red indicates there was less forest carbon in 2020 than there was in 1990, and blue indicates there was more carbon in 2020 than there was in 1990⁹

⁸ Australian Government Department of Industry, Science, Energy and Resources (2021) [Quarterly Update of Australia's National Greenhouse Gas Inventory: March 2021](#).

⁹ Roberts, G., Waterworth, R., de Ligt, R., McKenzie-McHarg, H., Francis, M., Roxburgh, S., Paul, K., Ximenes, F., (2022) *Carbon Balance of NSW Forests – Methodology and Baseline Report*, NSW Natural Resources Commission

2.2 People and forests

2.2.1 Aboriginal groups deliver new insights on cultural heritage

The program commissioned Firesticks Alliance Indigenous Corporation – an Indigenous-led network – to coordinate a process to assess Aboriginal cultural values and renewal in forests in fire-affected areas. This role supported case studies in different forests and fire-impacted areas of the state, and delivered on-ground cultural and economic support for local Aboriginal communities.

The Coffs Harbour, Tamworth and Brungle-Tumut Local Aboriginal Land Councils have led on-ground values and renewal assessments in their respective regions. The case studies identified cultural Aboriginal cultural values and their condition prior to the fires, and assessed the impact of the 2019-20 wildfires on these values. The case studies were guided by local steering groups and involved assessments of diverse Aboriginal values before and after the 2019-20 wildfires.

Key findings emerging from these case studies include:

- there are significant knowledge gaps around Aboriginal cultural values (both pre- and post-fire), with increasing knowledge, identification and protection of cultural values where Aboriginal people had increased access to or involvement in the management and custodianship of an area
- the fires have had significant impacts on many cultural values and practices, although priority sites (such as the rock art at Kukra on Wattleridge IPA) were able to be actively protected on Aboriginal managed lands and other key sites (including the Chambigne Rock Art Site and a known bora ground) were reported to be unaffected
- many cultural values have been destroyed or are at higher risk due to the fires, for example burnt scar trees and stone artefacts that have been made brittle or exposed to erosion risks – there is a concern that cultural sites will be deregistered or devalued where tangible cultural values are damaged or lost
- post-fire site visits produced new records of cultural values, including scar trees, artefact scatters and cultural resource sites, that were previously inaccessible due to vegetation
- with the exception of Aboriginal managed lands, Aboriginal people are not adequately involved in land management and decision making, including the identification, management, and monitoring of cultural values.

Importantly, as well as assessing pre- and post-fire cultural values, the case studies had a range of broader beneficial outcomes. For example, the project facilitated new and stronger partnerships between Aboriginal people and NSW Government land management agencies, provided opportunities for Aboriginal peoples to learn from specialists and undertake training, and enabled on-Country discussions and learning across various land tenures. Notably, all participants expressed a desire to continue building on the work undertaken during this project, to keep learning from each other and Country, and to build a community of practice and mentoring network.

Case study reports are available on the [Commission's website](#), along with a summary report capturing overarching findings and recommendations. A [video](#) has also been produced showing how the Banbai Rangers are leading Aboriginal values assessments on the Wattleridge Indigenous Protected Area and other tenures in northern NSW after the 2019/20 wildfires.

2.2.2 Citizen scientists engaged on-the-ground and virtually

South coast monitoring - ForestEye pilot project

Under the ForestEye pilot project, volunteers are trained to set-up remote sensor cameras and two different acoustic monitoring devices to monitor wildlife at selected sites. The pilot project was delivered over two days in December 2021 in the Bega Shire Valley NSW. Nine volunteers from nearby local areas participated in the pilot. The equipment was set up and then remained at the sites for a period of two weeks, at which point it was then collected by council staff.

The images collected have been uploaded to DigiVol for tagging, and the acoustics sent to the DPI team for analysis as part of the FMIP pilot program.

Banbai Rangers fauna monitoring

The Banbai Rangers undertook fauna monitoring on the Wattleridge Indigenous Protected Area (IPA). Ecologists supported the Banbai Rangers to deploy remote sensor cameras and two different acoustic monitoring devices to monitor wildlife at selected sites over two-weeks. Specialised computer-based fauna recognisers will analyse audio data in collaboration with the Rangers. Camera images will be uploaded to the Australian Museum's DigiVol crowdsourcing platform for Rangers to access and identify fauna, along with other citizen scientists.

The project has been documented in a [video](#). Data from this project will be used to ensure a statistically valid and robust design to expand the monitoring program as well as provide important insights into data collection, analysis, and biodiversity monitoring in the IPAs and NSW forests more broadly.

DigiVol and Australian Citizen Science Association partnership

The FMIP partnered with the Australian Citizen Science Association to help connect with the citizen scientist community. Images from the South Coast ForestEye pilot have been uploaded to the Australian Museum's DigiVol crowdsourcing platform for volunteers to identify fauna and experience the tagging process of remote camera images. This data is then stored by the commission for later use.

Images collected by the Banbai Rangers are in the process of being uploaded to DigiVol for identification by citizen scientists.

FrogID in state forests

The aim of the FrogID project is to develop long-term citizen science frog monitoring sites in state forests, in partnership with FrogID through the Australian Museum. FrogID records from the monitoring sites will be added to future species occupancy models and species distribution models.

Four signs will be installed at each site, which include Cobrabaid-Wild Bull (Mount Boss), Swams Crossing (Kerewong), Coopernook Forest (Coopernook) and The Pines Picnic Area (Olney). The signs brief the general public on the role of frogs in the environment and how to record frog calls using the app. The signs also detail the predicted frog species that might be found in each location. The sites were selected based on target frog species, with a consideration that the sites needed to be areas frequented by the public (such as nearby campgrounds).

Progress to date on this project include finalising the sign locations, securing sign fabrication and planning installation, drafting of sign designs and text including frog images and logos. Sign installation is to occur before Spring 2022.

2.2.3 Data management, sharing and re-use

The program's focus on data management recognises that the value of monitoring programs is in the data that they generate, and the insights derived from that data. This value is maximised through encouraging data sharing and reuse, including public access to the data.

The program is data intensive. The insights generated by the projects required the management and analysis of a broad array of datasets. The program engaged with a range of stakeholders to identify, procure and share datasets across government agencies, research institutions and other service providers.

Consistent with the [NSW Government Open Data Policy](#), the program has prioritised the timely sharing and reuse of the data generated by the program. Complete datasets are being made available for industry, research institutions and other government agencies. For example, data for the following have been publicly released:

- flora and fauna baselines and trends
- forest extent, condition and health baselines and trends
- forest water catchments baselines and trends
- soil stability and health in forest catchments baselines and trends
- carbon balance of NSW forests baselines and trends.

The program has used existing government data management infrastructure to make program data publicly accessible, including the [NSW SEED portal](#) and [TERN data discovery portal](#). Some spatial data has also been transformed to be made more readily available to the general community through the [NSW Spatial Collaboration Portal](#).

Program generated data is being used to satisfy the NSW Government forest management reporting requirements. To date, over 360 terabytes of data have been publicly released, and Government agencies and research institutions have indicated their interest in using program generated data in subsequent research programs.

2.2.4 Forest-dependent jobs

The Committee commissioned researchers at Synergies Economic and Vertarra consultancy groups to develop a reliable method to quantify forest-dependent jobs across all relevant sectors in NSW.

The researchers found that current estimates for forest-dependent jobs focus on direct employment in commercial forestry activities. There is limited information on indirect employment generated by forestry activities in other sectors of the NSW economy, or other activities in NSW forests such as recreation, tourism and apiary.

The researchers delivered an interim method that identifies individual activities that depend on forests for employment. The method requires consultation with stakeholders in relation to each of the activities to assess the linkage between the activity and direct employment.

The researchers applied and piloted the method on the NSW north coast, encountering several challenges including difficulties in obtaining employment and expenditure data from agencies directly related to forest-dependent activities. There were also issues consulting with the timber and wood product industry, ecotourism, recreation, and sporting, health, and fitness organisations due to the impact of COVID-19, the 2019-20 bushfires and 2021 floods, and concerns about commercial sensitivity.

The researchers recommended a range of actions to improve the interim method, including:

- further engagement with the forest-dependent timber, tourism and recreation sectors to secure more detailed data
- NSW agencies further defining job-dependent activities and associated data.

2.2.5 Evaluating the forest road network

Forest roads are the primary contributor to erosion that impacts upon waterway health. The design and management of forest roads involves a number of NSW government agencies, including FCNSW, NPWS, Soil Conservation Service, Rural Fire Services, Local Government and landholders engaged in private native forestry.

The overall aim of this project is to develop an evidence-based method to assess the effectiveness of forest road network design and management in reducing soil erosion and maintaining in-stream water quality. The project objectives are specifically to:

- apply existing methods to ensure forest road network design and management maintains forest environments as catchments that provide high quality surface water
- draw on peer reviewed literature to establish a field survey method to assess the adequacy of existing road drainage (including stream crossings) to reduce soil erosion and protect water quality
- select and assess a sample of forest road networks across different tenures in NSW.

A [discussion paper](#) and [draft method](#) have been prepared and workshopped with NSW public land managers. The risk assessment framework used in this project to determine likely impacts on waterways from the forest road network is shown in **Figure 7**. The likelihood assessment involves two models, specifically the:

- **state-wide sediment delivery potential model (the state model)** – estimates the total mass of sediment delivered to waterways from 100 metre long segments of unsealed forest roads during a nominal storm event, and ranking all forest road segments as either high, medium, or low sediment delivery potential
- **local scale sediment delivery potential model (the local model)** – predicts the sediment delivery potential of road network sections and quantifies the potential reduction in sediment delivery with changed road drainage and/or associated mitigation measures.

Work on this project is now complete, including:

- refining the method and modelling based on field work
- piloting the method and modelling in sample forest road networks
- preparing a work plan to evaluate NSW forest road networks.

A final report is expected to be released in mid-2022.

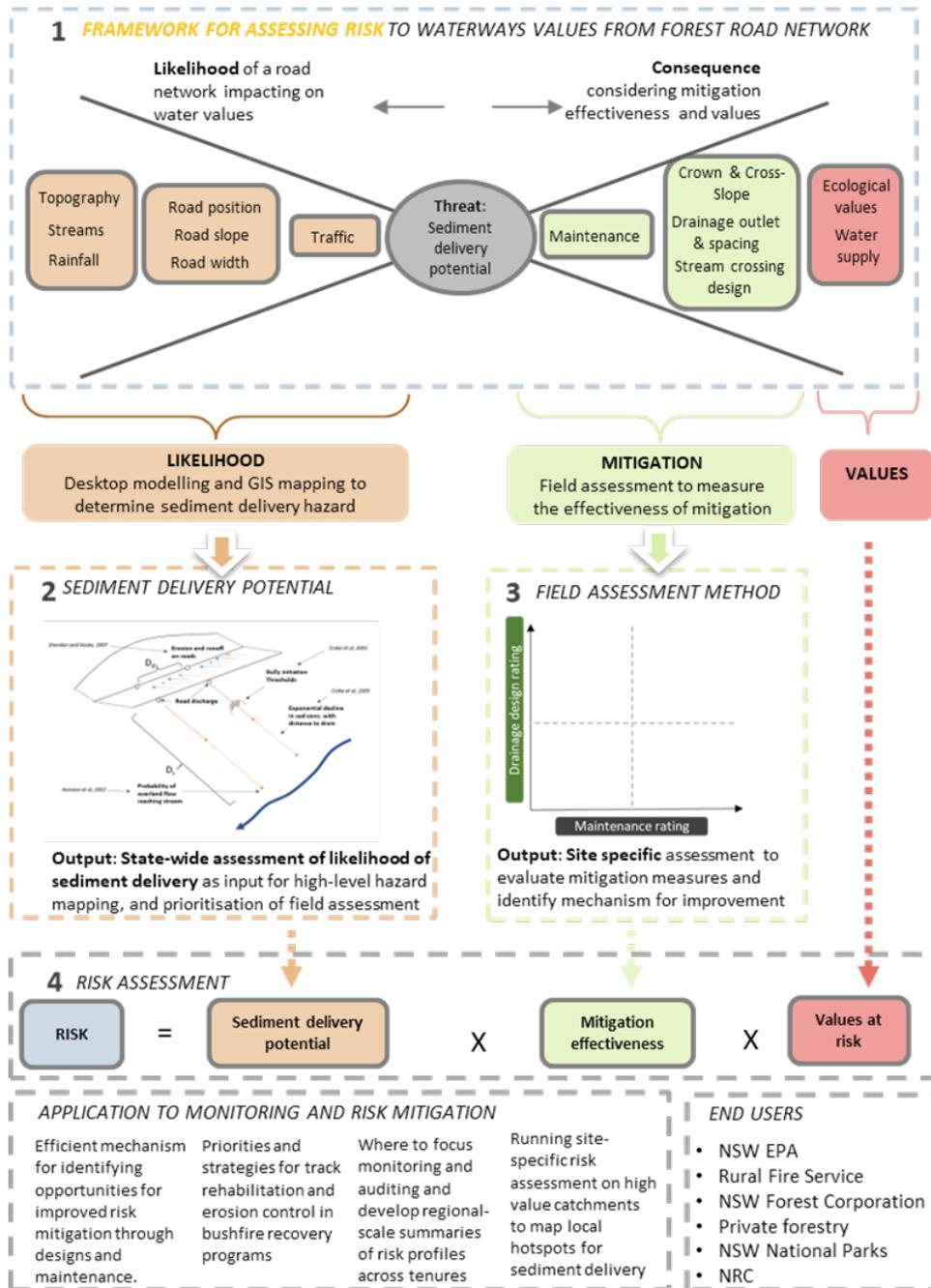


Figure 7: Risk assessment framework for impacts on waterways from the forest road network

2.2.6 Developing future scenarios for NSW forests

The Committee endorsed an approach to develop [future scenarios for NSW forests](#), drawing on existing knowledge and expertise on strategic scenario development across the NSW Government and its knowledge partners. The NSW future forest scenario development process provides a structured approach to exploring the complex and competing influences on forest management in NSW.

A series of five interactive workshops were held from September to November 2021, followed by consultation with individuals and small groups on a suite of proposed scenarios from November 2021 to February 2022. All NSW Government agencies responsible for managing or monitoring NSW forests across all tenures were involved through members of the NSW Forest Monitoring Steering Committee members or their nominees.

Participants provided insights from their own experience and knowledge about the values that different parts of society might have for forests, the processes that have driven change in the past and might drive change in the future. Key certainties and uncertainties of drivers of change were identified for:

- demography
- community values (forests for nature, forests for society, forests as culture)
- technology
- economy
- environment (including climate change)
- governance/politics/law.

Eight exploratory scenarios were developed to represent different plausible futures for NSW forests to 2050 (**Table 2**). The scenarios span a spectrum from optimistic to pessimistic and are designed to prompt further exploration of the opportunities and challenges of alternative policy and forest management decisions.

Table 2: Eight scenarios representing different plausible futures for NSW forests to 2050

Outlook/tone	Forest extent and condition compared with 2022		
	Less	Similar	Greater
Optimistic	-	<ul style="list-style-type: none"> ▪ Beautifully Aligned ▪ Respecting Country ▪ Vibrant Economy 	<ul style="list-style-type: none"> ▪ Restored NSW
Neutral	<ul style="list-style-type: none"> ▪ Neglected 	<ul style="list-style-type: none"> ▪ Regional Devolution 	-
Pessimistic	<ul style="list-style-type: none"> ▪ Hostilities Continue ▪ The Great Withering 	-	-

Recommendations are provided for next steps. Future forest thinking will be most powerful when embedded in the culture of organisations responsible for planning and managing NSW forests.

2.3 Fire in the landscape

2.3.1 Post-fire impacts on koalas assessed

The FMIP funded research into the impact of the 2019-20 wildfires on koalas and their habitat in north-east NSW. The research used existing pre-fire data and analysis combined with targeted post-fire sampling to opportunistically address knowledge gaps around the impacts of fire on:

- koala density (site scale)
- koala occupancy (regional scale)
- nutritional value of trees and sites for koalas.

Preliminary findings from this research include:

- for local koala populations, areas with a greater extent of medium or high fire severity experienced large declines in koala density, while in unburnt or predominantly low fire

severity areas, koalas continued to be widespread, with little to no signs of decreased local population density

- koalas were temporarily absent in some areas where high fire severity dominated the landscape, but localised recovery was evident after a year
- at the regional scale, there was no overall decline in post-fire koala occupancy detected, noting that analysis of regional occupancy can include increasing and decreasing subpopulations at finer scales
- key koala browse species¹⁰ offer improved nutritional quality after fire, with analysis showing post-fire epicormic growth having higher nutritional quality (higher levels of protein (digestible nitrogen), and higher moisture content) than mature leaves from the same trees sampled pre-fire
- in contrast, the nutritional quality of non-preferred browse species¹¹ decreased after a fire, with lower protein availability in the epicormic regrowth
- forests with a high abundance of koala browse species may therefore be particularly important for maintaining koala habitat nutritional quality following wildfires.
- future fires may lead to more significant adverse effects as habitat quality, connectivity and refuge areas may decrease, and koalas may have less opportunity to recolonise between fire events.

2.3.2 New methods to assess post fire events

The program engaged researchers at the NSW Department of Planning and Environment to lead and deliver tools and methods to assess and predict vegetation recovery after post-fire events.

The project developed new, innovative [remote sensing methods](#) to monitor post-fire vegetation recovery and estimate regrowth after a forest fire event. The project compared pre-fire and 1-year post-fire imagery. This allows important baseline information for on-going assessments at regular intervals.

The project undertook a comprehensive literature review, developed and tested new modelling platforms and collected field data to validate the model. The post-fire spectral recovery method is designed to fully integrate with the NSW *Fire Extent and Severity Mapping* (FESM) program.

The research also focused on complementary lines of research including modelling to predict likely time for full vegetation recovery, analysis on historical fire severity and patterns and testing the extent and application of LiDAR capabilities.

Researchers have published this research in a peer-reviewed [journal](#). This research found post-fire recovery generally aligned with regional climate and productivity. For example, sub-tropical bioregions in NSW's north-east, which offer faster growing environments, had the highest rates of recovery. Bioregions with cold climates and slower growing environments – for example, in the alpine and montane bioregions had the lowest rates of recovery.

The effect of fire severity on recovery varied depending on the region, with fire severity having little effect on recovery in the north-east, but much stronger effects in the alpine areas and the South East Corner.

¹⁰ Species of the subgenus *Symphomyrtus*, also known as “symphyomyrtle” species, such as Sydney blue gum, small-fruited grey gum, northern grey ironbark and red mahogany

¹¹ Species of the subgenus *Eucalyptus*, also known as “monocalypts”, such as blackbutt, white stringybark, and broad-leaved white mahogany.

2.4 Evidence for sustainable forestry

2.4.1 Committee continues to oversee forestry monitoring on public land

The [Coastal Integrated Forestry Operations Approval](#) (Coastal IFOA) sets out the rules for native timber harvesting in New South Wales (NSW) coastal state forests and establishes environmental outcomes that must be achieved under the approval. The Coastal IFOA requires that the approval conditions are monitored to ensure they are effective in meeting the required objectives and outcome statements.¹²

To meet this requirement, the Committee oversees the design and implementation of the [Coastal IFOA Monitoring Program](#). The program sets out strategies to monitor and research forest health, biodiversity, water quality and aquatic habitat, and wood supply.

The program has completed (or near completed) requirements to establish scientifically valid environmental and wood supply baselines to track and evaluate effectiveness of the Coastal IFOA conditions (**Section 3.1**). The Commission is now working with agencies and other experts to finalise the sampling design and approach for ongoing forest health and fauna trend monitoring.

Other research, monitoring and review activities include:

- research into the [implications of changing fire intensity and regimes](#), including risks to the achievement of the Coastal IFOA objectives and outcomes from the 2019/20 fires and predicted changes to future fire regimes
- [species management plan reviews](#) for the Milky Silkpod, Rusty Plum and Southern Brown Bandicoot
- 'annual health check' of the Coastal IFOA Monitoring Program, reviewing the results of the monitoring program to identify any implications for the IFOA conditions and priorities for further monitoring or research.

Further, there is a range of ongoing research and evaluation projects underway, including:

- exploring approaches to model hollow retention and recruitment under the Coastal IFOA, and ongoing data collection to support such an approach
- partnering with the NSW Saving our Species program to test and compare the detectability of the Hastings River mouse using a range of novel survey methods and technologies
- investigating the use of drones to improve detection for cryptic koala and greater glider populations, with surveys to be undertaken in winter 2022
- reviewing drainage feature crossings and roading by using remote imagery and surveys to assess the hydrological connectivity of the road and stream networks
- developing a method to readily map post-fire erosion, using aerial imagery collected pre- and post-fire in the catchment of the Tumut River and Blowering Dam Reservoir
- evaluating the effectiveness of species and habitat survey and modelling conditions and practices used in the Coastal IFOA.

For further information about the Coastal IFOA Monitoring Program, including [annual reports](#) and information about completed and ongoing projects, refer to the [Commission's website](#).

¹² [Coastal IFOA Conditions](#) (Chapter 8) and [Coastal IFOA Protocols](#) (Protocol 38).

2.4.2 Committee to oversee forestry on private land

Private Native Forestry is the sustainable management of native forests on private property for timber production in line with the objects of Part 5B in the *Local Land Services Act 2013*. The rules for forestry on private land are established in four codes of practice (the codes), which cover Northern NSW, Southern NSW, River Red Gum Forests, and Cypress and Western Hardwood Forests.

In May 2022, the NSW Government released [revised PNF Codes](#), following [review and advice](#) from the Commission regarding finalisation of the codes.

The PNF Codes establish new monitoring, assessment and adaptive management requirements.¹³ As a result, the Committee, independently chaired by the Commission, has been given the following oversight roles:

- developing and overseeing a Private Native Forestry Monitoring, Evaluation and Reporting (PNF MER) framework
- conducting annual checks to ensure the evidence base, including maps, is up to date, identify emerging evidence from monitoring and research, and opportunities for improvement
- overseeing updates to the PNF Koala Prescription Map, in collaboration with agency scientists and experts
- overseeing a risk-based review of threatened species protections for key species that will be carried out by a cross-agency technical review team
- formally assessing the data and evidence every five years and advise relevant Ministers whether there is sufficient evidence to warrant a review of the codes.

¹³ PNF Codes Section 4.3 [2] [3]