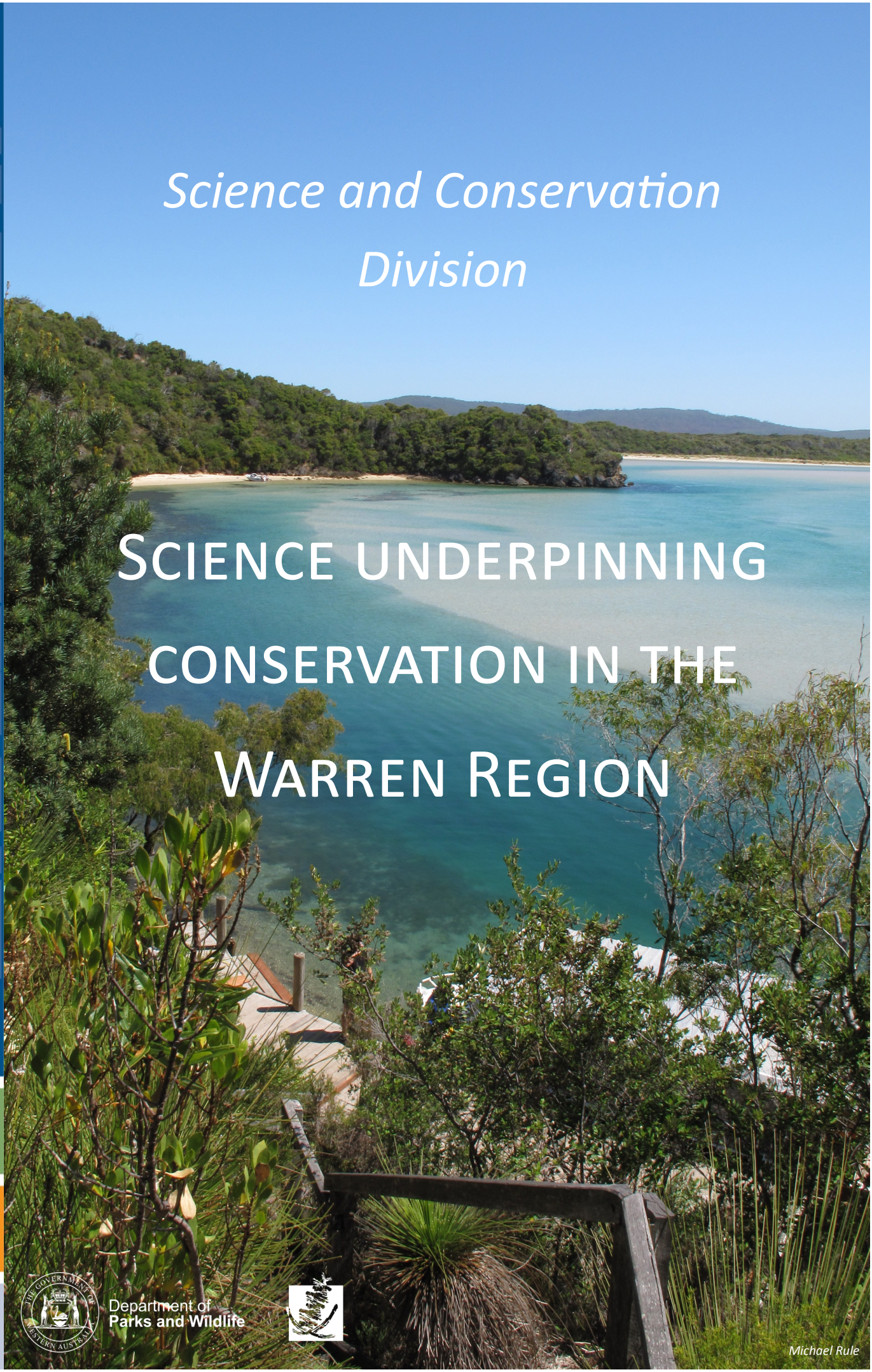
Science and Conservation Division

Science underpinning conservation in the Warren Region



Department of Parks and Wildlife

Michael Rule

FOREWARD

Effective communication of the outcomes of science is particularly important for ensuring the results inform conservation policy and wildlife, forest and parks management practice. Science undertaken in the Science and Conservation Division is carried out in collaboration with staff in the regions and our research partners, which include CSIRO, universities and industry. We highly value these partnerships, which deliver immense benefits in providing a scientific, evidence-based approach to conservation.

To facilitate communication with all regional staff we have produced a series of non-technical publications that describe the science we are undertaking in each of the regions of the Department. These 'Science in the Regions' publications capture a snapshot of current science activities that support wildlife, forest and parks management in each region, and are available on the website. Please contact any of our scientists if you would like more information on any of the topics described here.

Dr Margaret Byrne, Director, Science and Conservation Division

Richard Robinson

Paul van Heurch

Lachie McCaw

Ecologically appropriate fire management

Developing fire regimes that maintain the diversity and ecological function of the tall forest ecosystems of the south-west requires knowledge of how fire impacts all elements of the forest ecosystem. Conducting controlled burning trials and following the recovery of species following wildfire are two contrasting approaches that will both inform future fire management.

The Nuyts Wilderness wildfire in March 2001 was widespread and intense, and significantly simplified forest structure and reduced habitat diversity. The intensity of the fire also depleted soil seed banks, further hindering forest recovery. Following the wildfire, scientists have been comparing the composition of invertebrate communities after the wildfire with those from long unburnt forests and from the fine-grain fire mosaic created by the Walpole burning trial. They found that the tall tingle and karri forests contain a high proportion of short-range endemic (SRE; species with ranges less than 10,000 km^2) invertebrate communities. Many uncommon or SRE invertebrates were recorded within a wide range of times since fire, indicating a wide range of fire tolerances in these species.

Scientists have also been following the effects of wildfire on forest fungi. Fungi play a key role in decomposition and nutrient cycling, they enhance soil structure and nutrient uptake by plants, and provide food for native animals. Scientists monitored the presence of fungal fruit bodies on burnt sites over time to examine changes in species composition and abundance. They found that may species of fungi responded directly to fire or were associated with the conditions that exist in karri forests after fire. The fungal community differed in structure with each year after fire for at least five years, showing that fire mosaics enhance fungal diversity.

This knowledge of how invertebrate and fungal communities respond to fire will be used to direct fine-grain patch-burning operations in the tall forests.

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FORESTCHECK is a long-term, landscape-scale monitoring program that seeks to inform the adaptive management of jarrah forests. Scientists are investigating how forest structure and biodiversity are affected by timber harvesting and silvicultural treatments (regeneration release through gap creation or regeneration establishment using shelterwood and selective harvesting), compared with forests that have never been harvested or were harvested more than 40 years ago. Monitoring is carried out on a series of 2 ha grids (65 grids in total) in seven locations within five jarrah forest ecosystems, with the grids located across ecological gradients associated with rainfall, evapotranspiration and soil fertility.

While the silvicultural treatments did not affect species richness or the abundance of understorey plants, the soil disturbance associated with timber harvesting was found to be an important contributing factor in altering plant species composition. The areas trafficked by harvesters, skidders and loaders are often subject to excessive disturbance and compaction, with consequent effects on soil and forest health. Scientists measured soil bulk density as a measure of soil compaction across the sampling grids. Although highly variable, the mean bulk densities for soils in areas that had been harvested were significantly greater than in areas that had never been harvested. The effects of machinery activity on soil bulk density were still apparent in the reference grids that were harvested more than 40 years ago. This information allowed scientists to revise the limits for soil disturbance and the criteria for moist soil harvesting operation in jarrah forest.

The silvicultural treatments favoured species with an abundant soil seed store (e.g. *Kennedia coccinea*) over those with woody stems that are vulnerable to mechanical disturbance. More species of small and medium shrubs were recorded in forests that had not been harvested or were harvested before 1960. While grids in the gap release treatment were well stocked with saplings and ground coppice, regeneration of seedlings in the shelterwood treatment was not adequate to satisfy regeneration stocking standards within 10 years of treatment. The silvicultural treatments had a significant impact on the composition of cryptogam communities (lichens and bryophytes). Half of all cryptogams recorded were found on coarse woody debris, and 40% of them depended on it entirely, emphasizing the importance in retaining coarse woody debris over a range of sizes and in various stages of decomposition. Each forest ecosystem supported a unique fungal community, and the species composition of macrofungi differed in each treatment. The landscape mosaic of mature forest and stands of forest at various stages of succession after timber harvesting, combined with a range of times since fire, is important in maintaining fungal biodiversity in jarrah forests.

Scientists found that the type of jarrah ecosystem and the year of sampling had a greater influence on macro-invertebrate communities than did the silvicultural treatments. The maintenance of a mosaic of mature forest adjacent to harvested forest, as well as retaining macro-invertebrate habitat within harvested areas, will help to maintain species diversity locally and across the jarrah forest ecosystems. The silvicultural treatments also had little effect on bird community structure or on individual species, despite the typically strong association of bird species with vegetation type and structure. Most of the birds found in the jarrah forest are widespread throughout the south-west and have evolved to be resilient to disturbance. For terrestrial vertebrates (mammals, reptiles and frogs) the effect of silvicultural treatments were examined in combination with the impacts of fox control. Fox control had a greater impact on terrestrial vertebrates than silvicultural treatment: three times as many individuals of native animals were recorded in areas that had been baited. While the disturbance from harvesting will temporarily favour some species, the silvicultural treatments did not negatively impact terrestrial vertebrate fauna.

The information gained from FORESTCHECK's systematic monitoring of the jarrah forests is used to guide future silvicultural practice, to ensure that timber harvesting in these forests is ecologically sustainable in the long-term.

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Ecosystem Science Program


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Understanding the causes of rapid woylie decline

The substantial and rapid decline in woylie (*Bettongia penicillata*) populations since 2001 has seen the woylie relisted as critically endangered. The decline has particularly affected the largest and most important populations. One of the first steps in addressing woylie decline has been to assess whether the decrease in woylie capture rates was indicative of a real decline in the populations. Scientists used a range of monitoring techniques, including live-cage trapping, sand pads, woylie diggings, nest-density surveys and spotlighting, to describe woylie populations and to verify that the decline was real. A 95% decline occurred in the largest of the woylie populations in the Upper Warren region between 2002 and 2008. Overall, woylie populations have declined by about 90%. Since 2008, monitoring has shown that numbers have remained stable at the regional level, except at Keninup and Warrup, where declines have continued.

The primary causes of the decline were also investigated, with disease and predation considered to be likely the most important factors. Scientists found the collapse in woylie populations was driven by the death of woylies, rather than by a failure to breed. The increase in woylie mortality was due to the interactions between disease and predation, rather than one primary cause, with diseased woylies more likely to be taken by feral predators. Scientists also discovered that fox baiting in an area allowed the numbers of feral cats to increase, and that feral cats were the primary predator involved in woylie decline. The collapse of woylie populations has also led to increased inbreeding in those populations most affected. Direct management of woylie populations is now required. The population in the Perup Sanctuary has increased from 41 founders in 2010 to around 600 in 2014. Woylies from the sanctuary have been translocated to areas of the upper Warren where predator control has been undertaken.

The monitoring of terrestrial vertebrates undertaken as part of the Kingston project has also shown decline in four other species (dunnart, wambenger, quenda and ngwayir) that have now suffered similar reductions in numbers (>90%) in the upper Warren. Based on this monitoring, the conservation status of the ngwayir (western ringtail possum, *Pseudocheirus occidentalis*) has been elevated to endangered.

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Tracking forest pests

In 2010–11, over 250,000 ha of jarrah forest was defoliated by the gum leaf skeletonizer (*Uraba lugens*), a moth whose larvae eat the leaves of a range of *Eucalyptus* and other members of the Myrtaceae. The decline in rainfall in the south-west of the state since the 1970s, and future predictions of a warmer and drier climate, means that conditions for invertebrate pests will change significantly into the future, and new invertebrate pests may emerge. Bull's-eye borer outbreaks, for example, are related to drought stress in plants and are likely to increase in the future. Gum leaf skeletonizer and jarrah leafminer are prone to extended periods of outbreaks. Scientists have been mapping the distribution of invertebrate pests, including outbreak boundaries and advancing outbreak fronts, using aerial and road-side surveys and remote sensing, as well as monitoring population levels. They have trialled a pheromone lure and trap system for monitoring gum leaf skeletonizer moths as an alternative to monitoring larval density on branch samples. Pheromone traps are an effective tool for monitoring gum leaf skeletonizer populations in jarrah forest with an open understorey, and have potential use as an 'early warning system' for the spread of gum leaf skeletonizer.

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Monitoring stream health

Forest management activities, particularly prescribed burning and timber harvesting, can alter stream water chemistry, hydrology, sediment processes and physical habitats, with consequent effects on stream water quality and macro-invertebrate diversity. The Forest Stream Biodiversity Monitoring Project began biennial monitoring of 51 sites throughout the south-west forests during spring of 2005. Scientists used an environmental monitoring tool developed by the Australian River Assessment Scheme (AusRivAS) to predict the number of aquatic invertebrate families found in streams that are minimally disturbed, which was then used as a benchmark to determine levels of stream disturbance. The number of invertebrate families actually recorded in streams is compared with the number predicted by the AusRivAs model.

The sites monitored covered a wide geographic area and included streams in catchments subject to a range of current and future harvesting activities and/or prescribed burns, as well as in conservation areas with little stream disturbance. Scientists found that the ecological rating for all of the stream sites varied each year, due to inter-annual differences in rainfall and streamflow combined with local disturbance. While 16 sites were rated as significantly impaired and eight as severely impaired, this was related to salinity, reduced flows due to low rainfall or to local disturbance, rather than to the amount of timber harvested or the area burned within a catchment. Most of these sites were in the drier, northern jarrah forests. Reduced stream flow associated with a drying climate had the greatest impact on aquatic invertebrate communities, but future silvicultural management should avoid exacerbating this threat.

The monitoring program provides information on the interaction of silvicultural management and a drying climate, and is used to predict how aquatic invertebrate communities are affected by both local- and catchment-scale disturbance as stream flows reduce in a drier climate.

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Which seeds from where? Best-practice seed collection for ecological restoration

For restoration programs, a conservative approach to collecting seed only from 'local' zones or of 'local provenance' has traditionally been advocated, based on the assumption of strong adaptation in plants to local conditions, or concerns about the potential deleterious genetic impacts of mixing seed from different populations. What constitutes a 'local' seed collection zone may, however, be difficult to define and, in a changing climate, not the most appropriate approach to ensure the establishment and long-term persistence of restored vegetation.

There is little information on patterns of local adaptation, genetic diversity, likelihood of hybridization and invasiveness for most of the understorey species in the jarrah and karri forests. Scientists are using genetic approaches to determine these factors in a number of understorey species commonly used to rehabilitate areas after logging. For coral vine (*Kennedia coccinea*) and dwarf sheoak (*Allocasuarina humilis*), the analysis has shown that seed can be sourced from the same landscape management unit as the area to be restored, or from nearby areas in an adjacent landscape unit. Genetic analysis of parrot bush (*Banksia sessilis*) and marri (*Corymbia calophylla*) is currently underway. Knowledge of genetic structure in forest species has been used to define seed provenance approaches in the Forest Management Plan.

A similar approach is being used to identify areas for seed collection for the restoration of areas of blackberry decline along the Warren and Donnelly rivers. Three study species, *Astartea leptophylla*, *Callistachys lanceolata* (wonnich) and *Taxandria linearifolia*, have been selected for analysis. Leaf and seed material from 12 populations of both *C. lanceolata* and *T. linearifolia* across three climate zones, and from 12 populations of *A. leptophylla* across four climate zones, has been collected, with genomic analysis of all species currently underway. Using seed from the most appropriate seed collection zone will ensure that plant communities restored along the river bank have the greatest chance of long-term success.

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Marine monitoring for better management

Long-term datasets help us understand the direction and rate of change in ecosystems, so that managers can identify change related to human activities from underlying natural change. The Western Australian Marine Monitoring Program (WAMMP) aims to provide such information to marine conservation managers, so that they can respond to changes in marine biodiversity and ecosystem condition as they become apparent. The program is a state-wide, long-term monitoring, evaluation and reporting program of both protected areas and threatened marine fauna.

Black bream (*Acanthopagrus butcheri*) is an estuarine species that is one of the most important recreational and commercial species in southern WA. Scientists have been monitoring the catch of black bream taken by anglers competing in the ABT fishing competition held within the Walpole–Nornalup Inlet. Over the years of the survey the 'catch per unit effort' of black bream has dropped considerably, from 8 fish per angler in 2007 to about 2 per angler in 2013. While catch per unit effort is only a crude assessment of the likely status of black bream populations, this measure, in combination with the decreasing number of anglers in the ABT competition who reach the bag limit of 10 fish, is likely indicative of a real decline in black bream size and numbers.

Based on the information gained from this monitoring activity, scientists have recommended that future research effort is directed towards assessing the stock and temporal patterns of black bream in the Walpole and Nornalup Inlets Marine Park, and determining the best method on which to base future assessments of black bream populations.

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Benthic indicators of inlet health

The predominantly marine conditions sustained in the inlets of the Walpole and Nornalup Inlets Marine Park means that their benthic invertebrate fauna is relatively more diverse than that of other inlets along the coasts of the south-west. Benthic invertebrate communities may act as indicators of changing environmental conditions, both natural (e.g. seasonal hydrological cycles) and management-related.

Scientists have been conducting surveys of the benthic invertebrate fauna of the inlets, with over 120 species identified so far. They are also working in collaboration with staff and students from Edith Cowan University to survey large bivalves on shallow sand flats, with three annual surveys now completed.

Bivalves from the genus *Soletellina* are the most abundant molluscs in the inlets, and may prove to be useful indicator species of environmental change. Analysis of changes in the spatial and temporal patterns of invertebrate communities in relation to environmental conditions is ongoing.

Understanding how benthic invertebrate communities respond to anthropogenic changes in water quality will guide future management of human activity in the marine park.

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