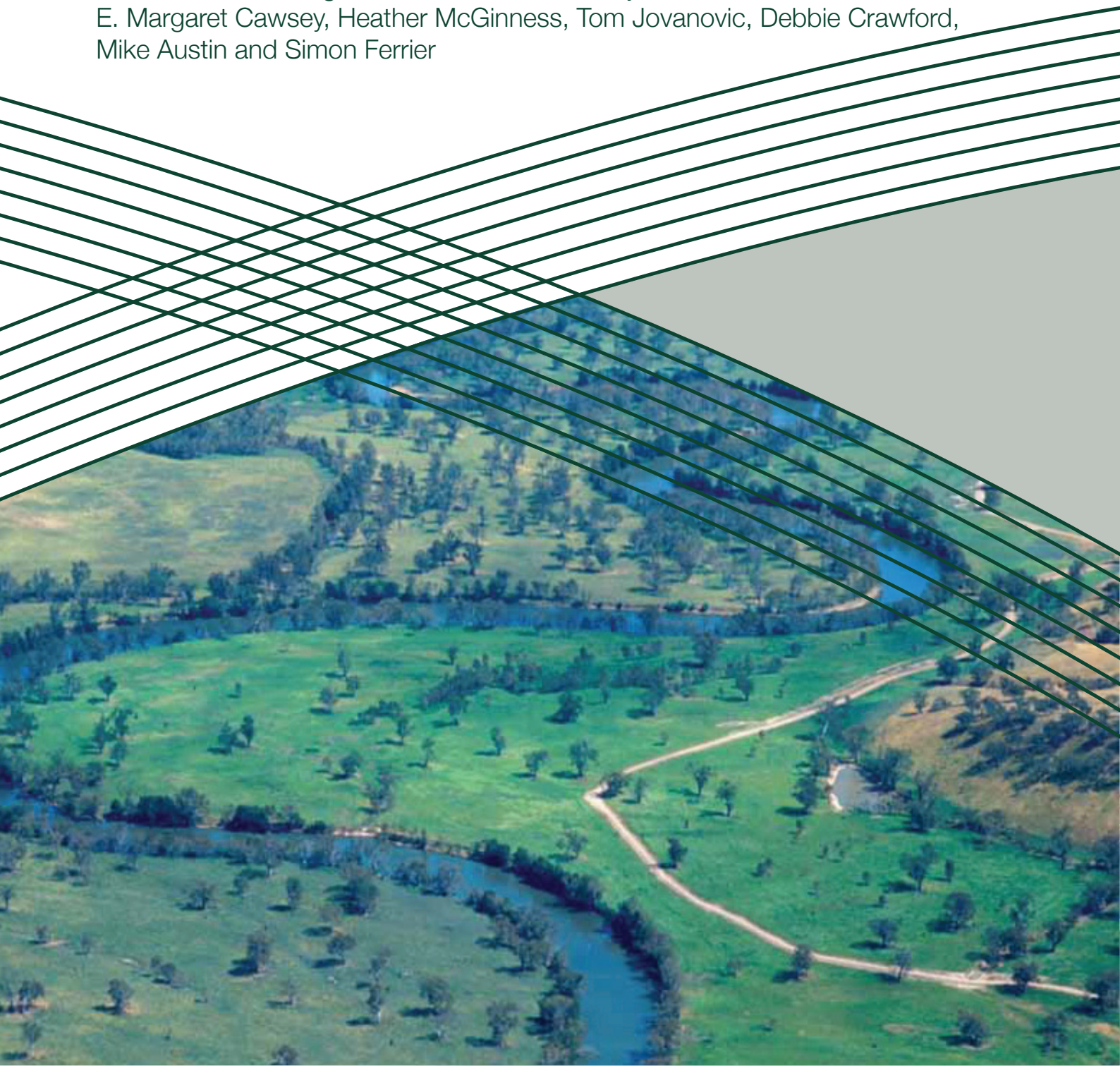


Designing landscapes for biodiversity under climate change

Summary for landscape managers and policy makers

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Executive summary

Climate change is expected to result in significant changes in temperature, rainfall and evaporation, with the degree of change projected to accelerate. As a result, Australia's native species will experience different local environments than they do now and will need to adjust to those environmental changes, move to live elsewhere, or go extinct. Large populations and well connected natural areas may be required for species to make these adjustments, but both of these have been impacted by alteration of land uses and fragmentation of natural areas. Thus, landscape design and management is one of the primary ways in which land managers can assist biodiversity under climate change. Under landscape design and management, areas to be managed and/or restored for biodiversity are planned in very specific locations over relatively large scales with the aim of achieving large populations, spread over multiple patches of native ecosystems in the landscape and intermingled with other necessary land uses.

Many landscape design and management initiatives are underway in Australia and they differ in their specific details. Unfortunately, it is not clear whether one set of these 'landscape design principles' is better than another as a climate adaptation action. This is because design principles are developed based on current landscapes rather than future, climate-affected landscapes. Yet future landscapes may be very different in terms of where we might find particular native species and in terms of land uses, including the amount of intensive agricultural production and plantings for carbon sequestration. All these potential changes could affect where native species live and the degree to which the landscape is connected to allow species movements. Thus, we need to evaluate how well different landscape design principles perform in future landscapes. Because we can't predict exactly what future landscapes will be like, we need to consider a broad range of possible futures and try to identify landscape design approaches that are likely to benefit native species across all of them.

To accomplish these goals, we modelled a range of plausible future landscapes and applied the most common current landscape design principles to these landscapes (as well as an aspirational design principle). We then evaluated the degree to which the design principles might improve the capacity of the landscapes to support populations of native species in the long term, and decrease their capacity to support two key invasive species. Our goal was to find one or more landscape design principles that improved all future landscapes for native species, as such an outcome would allow us to plan for the future without having to know precisely what the future will look like.

In the final report for this project, we worked with two case study landscapes: South-East New South Wales (the Southern Rivers, Murray and Murrumbidgee Catchment Management Authority areas) and North-East New South Wales (the Border Rivers/Gwydir, Namoi and Northern Rivers Catchment Management Authority areas). We modelled 48 future versions of each of these landscapes based on:

- Four 'storylines' of land-use change linked to different potential future climates as well as social and economic drivers and barriers of land-use change (defined with a group of experts across disciplines including agriculture and forestry).
- Two global climate models which project differing rainfall patterns and were used to model where native vegetation communities will be in the future.

- Six landscape design principles based on the amount and placement of new areas of native vegetation in the landscape (three based on where Australian landscape managers currently place restoration projects in their landscapes, one with random placement of restoration, one with no restoration, and one with a much more restoration than currently considered achievable).

We then evaluated our 96 future landscapes using a 'metapopulation capacity' model, which uses data on species' habitat preferences and movement abilities to estimate a landscape's ability to support populations that are large enough to persist long into the future. We ran the model for four groups of native species (native orchids, animals that specialise on wet forest environments, and two groups of animals that specialise on grassy woodland and dry forest environments) as well as two invasive species (red fox and peppercorn tree).

In the supplement to the final report, we worked with a third case study landscape (the area managed by the Wimmera Catchment Management Authority) to provide a validation of the results derived from the New South Wales landscapes. We used a subset of the original land-use change 'storylines' and landscape design principles and compared the results from analysing all three study landscapes as well as the Wimmera by itself to the results presented in the original final report for the two NSW landscapes. Across all three study landscapes and all futures, we were hoping to find that one or more of the current, implementable design principles tended to improve the metapopulation capacity of landscapes (increase it for native species groups and decrease it for invasive species) better than the other principles.

Instead, we found that only our aspirational design principle – restoring landscapes to ~30% native vegetation cover – reliably improved future landscapes relative to current landscapes. None of the currently used design principles was better than another and none of them arrested declines in the capacity of landscapes to support native species, on average. However, there were some differences between species. The capacity to support wet forest specialist fauna declined regardless of design principles, and the invasive peppercorn tree increased with landscape improvements for native species. Improvement in the capacity to support populations into the future also depended on land-use change storyline, so spatial planning of changes in land use may provide an additional management approach to climate adaptation for biodiversity management. These conclusions applied across all three study landscapes, though the patterns were weaker in the Wimmera, where climate-related changes in land uses and native vegetation may not have as dramatic an impact on persistence of native species as in the New South Wales landscapes.

Collectively, these results suggest that current approaches to landscape design and management may not be sufficient to serve as climate adaptation strategies for biodiversity. The total amount of restoration is more important than detailed spatial configuration to counteract declines in biodiversity from climate-related changes in land use and suitable habitat, at least at very large landscape scales. While sobering, these results suggest several useful and even positive key messages for how best to manage landscapes for terrestrial biodiversity under climate change.

Key messages

Act locally, but coordinate local efforts to manage a landscape

- As the detailed spatial arrangement of restoration projects may not have a strong influence on landscape-scale outcomes, we can enable local managers to make local decisions that suit their goals and opportunities without compromising goals at larger scales.
- Thus, to construct larger-scale landscape initiatives (which may be needed to facilitate species' range shifts), we may simply need to ensure that local efforts are spatially aligned to create large, continuous areas managed for landscape improvement. Such cross-boundary corridors for climate change could then be managed by letting different landscape managers within those boundaries make their own individual decisions.

Restoration should be paired with targeted alien invasive species management

- Not all alien invasive species will benefit from increasing the amount of native vegetation and landscape connectivity, but some will. These are most likely to be those that co-occur with native vegetation (i.e. those that tend to be invasive specifically within areas reserved for native communities rather than those that are problematic on agricultural or urban lands) and that may rely on native species as dispersal agents. Thus, landscape design and management initiatives should include coordinated plans to manage the risk of spread of these particular species.

We need much more restoration, but there will still be 'climate losers'

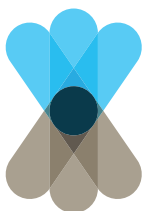
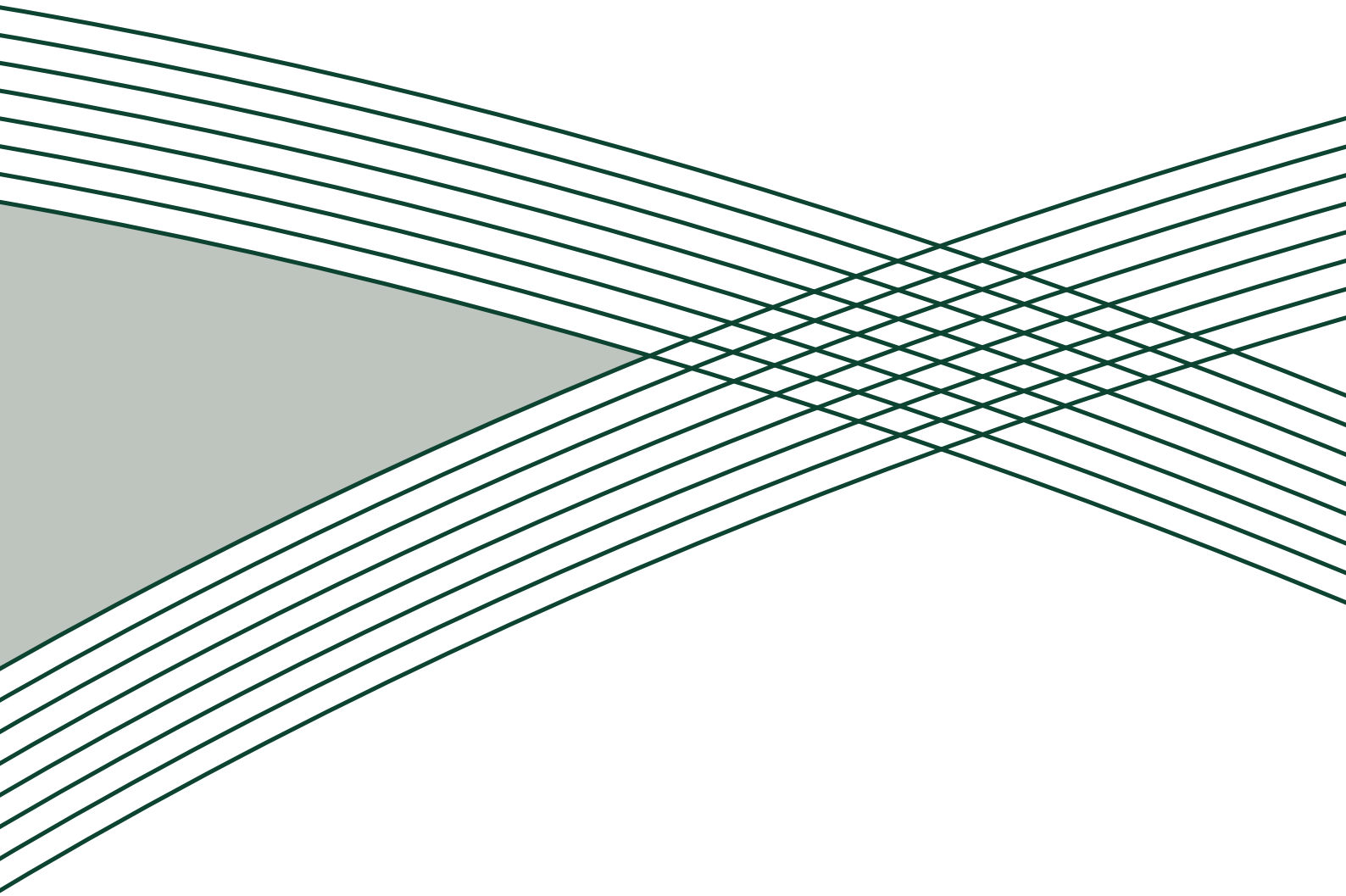
- To arrest biodiversity declines, we may need an order of magnitude more restoration than we are planning at present. Restoring ~30% native vegetation cover at the scale of multiple catchments may be needed to counteract the effects of climate-related changes in land use and native vegetation and ensure that we actually improve the ability of landscapes to support viable populations of native species into the future.
- Some species will still be 'climate losers' – species that will probably lose so much suitable area purely due to changes in climate (like those that are specialists on wet environments) that there may be little landscape managers can do to prevent local and regional declines in their chances of persisting.

Focus restoration efforts in priority areas

- Achieving 30% native vegetation cover at the scales of multiple whole catchments may currently seem unattainable. Yet that goal should be achievable at smaller scales in some landscapes. Thus, by concentrating restoration efforts in priority areas even more than we do at present, we could manage habitats to support single viable metapopulations, then build greater landscape-scale efforts over time.

Consider spatial planning of all types of land-use change, not just restoration

- Integrating spatial planning of productive land uses with restoration of native vegetation has the potential to improve future landscapes for biodiversity without the need to achieve ~30% native vegetation cover. Restricting the loss of paddock trees in areas where they best supplement and connect more intact native vegetation could be critical. We need to encourage innovative on-ground approaches to integrated land-use planning, where societal needs for both agriculture and biodiversity intersect, and monitor the results to gain better information about cost-effective options.



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