

CLIMATE CHANGE, WILDFIRES AND WETLAND ECOSYSTEM SERVICES: GOVERNING TRANSFORMATION

PHILLIPA C MCCORMACK*

Australia's 2019–20 fire season has been described as the 'Black Summer'. Vast swathes of the continent burned, including areas that have not been fire-prone in the past, such as wet rainforest and alpine wetlands. This article considers the implications of more frequent and intense wildfires for wetland ecosystems and the extremely valuable ecosystem services that they provide. The article investigates what Australia's laws have to say about restoring ecosystem services after extreme events such as fire. In particular, the article considers the extent to which existing laws anticipate the possibility of ecosystem transformation, asking: what do our laws require if restoration is not possible?

I INTRODUCTION

Australia experienced a catastrophic 2019–20 bushfire season. Fires razed large areas of the continent, from Queensland, down the east coast to Tasmania, and across to Western Australia. One area that was heavily impacted was the Macquarie Marshes — a large, Ramsar-listed wetland and one of Australia's most important waterbird nesting sites, where up to 90 per cent of the site's reed beds were burned.¹ Fires are increasingly burning ecosystems that have not been fire-prone in the past, including Gondwana Rainforest in Eastern Australia² and

* Lecturer, School of Law, University of Tasmania.

¹ Jessie Davies, 'Ramsar-Protected Macquarie Marshes Wetland on Fire with 90pc of Crucial Reed Bed Razed', *ABC Western Plains* (online, 28 October 2019) <<https://www.abc.net.au/news/2019-10-28/macquarie-marshes-on-fire-90pc-reed-bed-razed/11645914>>.

² Michelle Ward et al, 'Impact of 2019–2020 Mega-Fires on Australian Fauna Habitat' [2020] 4 *Nature Ecology & Evolution* 1321. Fires affected approximately 54 per cent of the Gondwana Rainforests of Australia and 81 per cent of the Greater Blue Mountains World Heritage Areas. See Department of Agriculture, Water and the Environment, *Wildlife and Threatened Species Bushfire Recovery Research and Resources* (online, 2020) <<https://www.environment.gov.au/biodiversity/bushfire-recovery/research-and-resources>>.

ancient and fragile alpine peatlands in central Tasmania.³ While much of Australia's biodiversity is adapted to fire, recent wildfires demonstrate a climate-driven change in intensity and frequency that represents a new threat to ecosystems and the services they provide.⁴ The implications of climate change for coastal wetlands have been examined in some detail in recent scholarship,⁵ but there is far less analysis of the threat of changing fire regimes to wetland ecosystems, or of the ways in which legal, policy and management regimes should anticipate and respond to this changing threat.⁶

Of course, wetland ecosystems are not alone in being threatened by changing fire regimes. However, wetlands provide a useful lens through which to assess the capacity for legal frameworks to promote restoration after extreme events such as wildfire, because wetland conservation laws are some of the few that set active restoration obligations and explicitly engage with the concept of ecosystem functions and services. Fire is also not the only threat to wetlands but, particularly when combined with other climate trends such as warming and drying, it has the potential to rapidly transform these ecosystems, with complex implications for their legal and conservation status.

The purposes of this article are threefold. First, it brings together scholarship about climate-driven changes to wildfire regimes and climate adaptation in wetland ecosystems. The analysis highlights how important it is to support adaptation in wetland ecosystems to maintain crucial ecosystem services. Second, having demonstrated that changing wildfire regimes pose a growing threat to wetland ecosystems in Australia, the article investigates what existing laws and policies have to say about restoring ecosystem services after extreme events. In particular, the article considers the extent to which existing laws anticipate the possibility of restoration failure or ecosystem transformation, asking: what do our laws require if restoration is not possible? And do our laws protect the conservation status of an area, even if it is no longer providing the ecosystem services for which it was conserved? The third purpose of this article is to draw

³ Tasmanian Climate Change Office ('TCCO'), *Tasmanian Government's Response — TWWHA Bushfire and Climate Change Research Project* (2015); Ward et al (n 2).

⁴ While acknowledging that controversy exists in the ecological, legal and philosophical scholarship about 'ecosystem services', the term is used here not as an economic calculation but rather to describe the rich, diverse ways that wetlands provide benefits to people.

⁵ Valerie Masson-Delmotte et al (eds), *Global Warming of 1.5°C: An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty* (Report, 2018) 181 ('IPCC 1.5°C Report'); Vishnu Prahalad et al, 'The Creation and Conservation Effectiveness of State-Wide Wetlands and Waterways and Coastal Refugia Planning Overlays for Tasmania, Australia' (2019) 81 *Land Use Policy* 502.

⁶ But see, generally, William R Moomaw et al, 'Wetlands In a Changing Climate: Science, Policy and Management' (2018) 38 *Wetlands* 183; CM Finlayson et al, 'Policy Considerations for Managing Wetlands under a Changing Climate' (2017) 68 *Marine and Freshwater Research* 1803.

lessons from climate adaptation law scholarship for responding to ecosystem transformation and changing ecosystem services.

Part II of this article briefly describes the rich diversity of wetland ecosystems in Australia and the range of ecosystem services that they provide. Part III synthesises climate projections about changing fire regimes and their implications for wetland ecosystem services in Australia. Part IV provides an overview of the ways that Australian conservation laws facilitate restoration after extreme events and the complexity of restoring disrupted ecosystem services to a site. Examples from governance instruments for the Macquarie Marshes Ramsar site and Tasmanian Wilderness World Heritage area demonstrate the complex web of law, policy, management and practice that guide restoration activities in protected wetland ecosystems. Part V applies recommendations from climate adaptation law scholarship to the particular case of wetlands and wildfire, demonstrating the need for a substantial shift in the way that we measure and respond to conservation success and failure. The article concludes in Part VI with a call for greater ambition and commitment to conserving the full richness and diversity of Australia's unique and threatened ecosystems.

II WETLAND ECOSYSTEMS AND THEIR SERVICES

Wetlands are found across the Australian continent from coastal mangroves and saltmarshes, to alpine sphagnum bogs and peatlands, to mound springs in arid regions,⁷ and they are crucial sites for both conservation and climate management. Wetland ecosystems are diverse, specialised environments that support unique flora and fauna and complex ecological processes. Wetland ecosystems also contribute to climate mitigation with their substantial capacity for carbon dioxide sequestration, and they facilitate climate adaptation by, for example, buffering coastal human and ecological communities from the impact of storm surges and sea-level rise.⁸ Wetlands are highly vulnerable to the effects of anthropogenic climate change, especially drying and warming trends, sea-level rise, and extreme events such as storms and fire.⁹ Drying wetlands can also release methane and other greenhouse gases and so, as these ecosystems are

⁷ Department of Agriculture, Water and the Environment, *Directory of Important Wetlands in Australia* (online, 2005) <<https://www.environment.gov.au/water/wetlands/australian-wetlands-database/directory-important-wetlands#inland>>.

⁸ Sandra Díaz et al (eds), *The Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services* (IPBES Secretariat, 2019); Ove Hoegh-Guldberg et al, 'Impacts of 1.5°C Global Warming on Natural and Human Systems' in IPCC 1.5°C Report (n 5) 233.

⁹ IPCC 1.5°C Report (n 5).

impacted by climate change, they also represent an important potential contributor to future warming.¹⁰

Wetlands provide a host of ecosystem services to human communities. Services provided by coastal wetlands have been well-documented and include provisioning services such as: fuel and fibre; regulating services such as carbon sequestration, protection from storm surges and erosion, water regulation and purification, and biodiversity conservation, including through the provision of habitat; cultural services such as spiritual, recreational and aesthetic values; and supporting services such as nutrient cycling.¹¹ A recent global assessment produced by the Intergovernmental Science–Policy Platform on Biodiversity and Ecosystem Services (‘IPBES’) noted that estuaries support 70 per cent of people worldwide and their extensive contributions to human wellbeing include intangible, often sacred, values.¹²

Permanent and ephemeral wetlands in arid regions, such as soaks, mounds and swamps, provide drought refuges and habitat for populations of freshwater fishes, amphibians, reptiles, birds and mammals taking advantage of sporadic water availability in otherwise harsh and dry environments.¹³ Arid wetlands also offer provisioning services in the form of livestock fodder in agricultural regions, along with regulating services in the form of sediment and nutrient retention, and cultural services such as Aboriginal cultural heritage sites.¹⁴ Inland and alpine wetlands provide services such as soil conservation (preventing erosion), flood control, water and air purification, and sources of food, fuel, spiritual and recreational values as well as important niche habitats for migratory birds such as Latham’s Snipe (*Gallinago hardwickii*) and the critically endangered Northern Corroboree Frog (*Pseudophryne pengilleyi*).¹⁵

Climate change is creating new and important roles for wetlands in providing ecosystem services. One of the best-recognised examples is mangroves and coastal wetlands slowing coastal accretion and saltwater inundation as sea levels

¹⁰ Allen Myles et al (eds), *Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C Approved by Governments* (Cambridge University Press, 2018) 12 (‘IPCC 2018 SPM’).

¹¹ Justine Bell-James, Tessa Boardman and Rose Foster, ‘Can’t See the (Mangrove) Forest for the Trees: Trends in the Legal and Policy Recognition of Mangrove and Coastal Wetland Ecosystem Services in Australia’ (2020) *45 Ecosystem Services* 101148.

¹² Nakul Chettri et al, ‘Status and Trends — Nature: Draft Chapter’ in Diaz et al (n 8) 89.

¹³ Roger Jaensch and Sarah Young, *Wetland Management Profile: Arid Swamps* (Queensland Wetlands Program, 2010); DA Roshier, AI Robertson and RT Kingsford, ‘Responses of Waterbirds to Flooding in an Arid Region of Australia and Implications for Conservation’ (2002) 106(3) *Biological Conservation* 399.

¹⁴ Jaensch and Young (n 13) 5.

¹⁵ A Wild et al, *Ecological Character Description: Ginini Flats Wetland Complex* (Unpublished Report, Australian Government Department of Sustainability, Environment, Water, Population and Communities, 2010).

rise.¹⁶ Wetlands are also increasingly recognised as important sites for climate refugia, in addition to their role as short-term refuges from extreme events such as drought and fire.¹⁷ Climate refugia are habitats into which species can shift or retreat and persist through extended periods of adverse climate conditions.¹⁸ Climate refugia will be crucial for biodiversity over coming decades,¹⁹ and healthy, functioning wetlands can play an important refugial role.²⁰

III CLIMATE CHANGE, WETLANDS AND CHANGING FIRE REGIMES

Global mean surface temperatures are now approximately 1°C above pre-industrial levels and are expected to reach 1.5°C of warming between 2030 and 2052.²¹ In Australia, temperatures are expected to warm more rapidly, reaching up to 6.6°C by 2085.²² Projections about changing patterns of rainfall and runoff in Australia are complex and uncertain,²³ but will occur in a context of ongoing decline, with over 85 per cent of the area of global wetlands already lost.²⁴

Climate change will have both direct impacts on wetland ecosystems, as a result of warming and drying trends, and indirect impacts as climate changes interact with existing stressors such as over-extraction, invasive species and changes in wildfire regimes.²⁵ Some wetland ecosystems will be more resilient in

¹⁶ See, eg, Oscar Serrano et al, 'Coastal Wetlands: Conservation of Blue Carbon Ecosystems for Climate Change Mitigation and Adaptation' in Gerardo ME Perillo et al (eds), *Coastal Wetlands: An Integrated Ecosystem Approach* (Elsevier, 2nd ed, 2019) 965.

¹⁷ CS James et al, *Identifying Climate Refuges for Freshwater Biodiversity across Australia* (National Climate Change Adaptation Research Facility, 2013) 2.

¹⁸ Toni Lyn Morelli et al, 'Managing Climate Change Refugia for Climate Adaptation' (2016) 11(8) *PLoS One* e0159909; April E Reside et al, *Climate Change Refugia for Terrestrial Biodiversity: Defining Areas that Promote Species Persistence and Ecosystem Resilience in the Face of Global Climate Change* (National Climate Change Adaptation Research Facility, 2013).

¹⁹ See, eg, Meddens et al, 'Fire Refugia: What Are They, and Why Do They Matter for Global Change?' (2018) 68(12) *BioScience* 944; Reside et al (n 18).

²⁰ A diversity of 'fire ages' in a landscape, including areas of long-unburnt habitat, is disproportionately important for climate refugia. See Dixon et al, 'More Long-Unburnt Forest Will Benefit Mammals in Australian Sub-Alpine Forests and Woodlands' (2019) 44(7) *Austral Ecology* 1150.

²¹ IPCC 2018 SPM (n 10) 4.

²² James et al (n 17) 2–3.

²³ Ibid.

²⁴ Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 'Summary for Policymakers' in Díaz et al (n 8) 11, noting (at 24) that only '13% of the wetland present in 1700 remained by 2000; recent losses have been even more rapid (0.8 per cent per year from 1970 to 2008)'.

²⁵ Although there is some uncertainty about the precise effect of interactions between existing threats and climate-driven changes, particularly in freshwater ecosystems. See A Reisinger et al,

the face of these impacts, such as those fed by groundwater systems, while others, such as coastal wetlands and those fed by rainfall and runoff, are highly vulnerable and may be irreversibly transformed.²⁶

A *Climate Impacts on Wetland Ecosystem Services*

The IPCC reported in 2019 that climate change will have severe impacts on the ecosystem services provided by wetland ecosystems, including as a result of increasing risks of species extinctions, biome transformations and changes in extreme weather events.²⁷ These impacts include likely disruptions to ecosystem functioning and loss of cultural, provisioning and regulating services such as flood control, food and fuel provisioning, and recreation.²⁸

In Australia, the Commonwealth Government's 2017 State of the Environment report found that '[c]limate variability and climate change, and associated changes in rainfall regimes, are the primary risks to inland water environments in both the short and long term'.²⁹ Wetlands in southern Australia will be particularly exposed to interactions between decreasing average rainfall and increasing occurrences of hot days and fire weather.³⁰ Climate change is expected to reduce winter rainfall by up to 40 per cent in southeastern Australia and 70 per cent in southwestern Australia.³¹ Drying trends will be exacerbated by both long periods of drought and higher evaporation in warmer temperatures, as well as interceptions from changing agricultural uses.³² In this context,

'Australasia' in VR Barros et al (eds), *Climate Change 2014: Impacts, Adaptation, and Vulnerability Part B: Regional Aspects* (Cambridge University Press, 2014) 1371, 1390.

²⁶ Finlayson et al (n 6) 1805. This depends on the ultimate extent of climate change and global climate mitigation actions: IPCC 2018 SPM (n 10) 4, 11.

²⁷ IPCC 1.5°C Report (n 5) 221.

²⁸ Ibid.

²⁹ Robert Argent, 'Outlook: Inland Water' in ID Cresswell and HT Murphy, *Australia State of the Environment 2016* (Web Page, Australian Government, 2017) <<https://soe.environment.gov.au/theme/inland-water/framework/outlook>>.

³⁰ Reisinger et al (n 25) 1374, 1379.

³¹ Ibid.

³² Such as the 'Millennium Drought' in Australia (1997–2009), which caused an 'unprecedented decline' in water availability in southeastern Australia, triggering severe water allocation restrictions for irrigators and urban water users, serious environmental impacts, and the suspension of national water-sharing arrangements. See Reisinger et al (n 25) 1377, 1387–8, 1391.

increasingly heavy extreme rainfall events will decrease water quality and increase erosion,³³ causing particular damage to wetlands.³⁴

Some wetlands, such as those in arid areas, may be more resilient to these changes because they are adapted to boom and bust cycles.³⁵ However, 'hotspots' of climate vulnerability in Australia include low-lying coastal wetlands, such as those in Kakadu National Park, where very small rises in sea level will result in saline intrusion.³⁶ Inland freshwater and groundwater systems that are already subject to over-allocation will also be particularly vulnerable to increased drought and changes in the timing and extent of flooding,³⁷ while peat-forming wetlands are particularly vulnerable to significant drying.³⁸

Wetland boundaries have already been observed tracking changes in climate,³⁹ and wetland species are also expected to redistribute with changing temperature and rainfall patterns,⁴⁰ though not necessarily at the same rate or in the same direction.⁴¹ Climate-driven redistributions will cause species assemblages to 'shuffle' with impacts on threatened species habitats as well as other wetland ecosystem services.⁴² Changes in species distributions and assemblages may also reduce the capacity of some wetlands to provide refuge from heatwaves and drought, despite increasing need for refuges and diverse and longer-term climate refugia.⁴³

³³ David Blake et al, 'Assessment of Post-Wildfire Erosion Risk and Effects on Water Quality in South-Western Australia' (2020) 29(3) *International Journal of Wildland Fire* 240; CN Dahm et al, 'Extreme Water Quality Degradation Following a Catastrophic Forest Fire' (2015) 60(12) *Freshwater Biology* 2584.

³⁴ Reisinger et al (n 25) 1374.

³⁵ Hans-Martin Füssel and Richard JT Klein, 'Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking' (2006) 75(3) *Climatic Change* 301; *Decision of the COP in its Eighth Meeting, Held in Valencia from 18–26 November 2002 Climate Change and Wetlands: Impacts, Adaptation and Mitigation*, Resolution VIII.11 (26 November 2002) 29.

³⁶ Reisinger et al (n 25) 1377.

³⁷ *Ibid.*

³⁸ *Ibid.*

³⁹ David A Keith, Suzette Rodoreda and Michael Bedward, 'Decadal Change in Wetland-Woodland Boundaries During the Late 20th Century Reflects Climatic Trends' (2010) 16(8) *Global Change Biology* 2300; Kerry Lee Rogers, Neil Saintilan and Craig Copeland, 'Managed Retreat of Saline Coastal Wetlands: Challenges and Opportunities Identified from the Hunter River Estuary, Australia' (2014) 37(1) *Estuaries and Coasts* 67.

⁴⁰ Rogers, Saintilan and Copeland (n 39).

⁴¹ Jeremy VanDerWal et al, 'Focus on Poleward Shifts in Species' Distribution Underestimates the Fingerprint of Climate Change' (2013) 3(3) *Nature Climate Change* 239.

⁴² Lochran W Traill et al, 'Managing for Change: Wetland Transitions under Sea-Level Rise and Outcomes for Threatened Species' (2011) 17(6) *Diversity and Distributions* 1225; Wayne A Houston et al, 'Climate Change, Mean Sea Levels, Wetland Decline and the Survival of the Critically Endangered Capricorn Yellow Chat' (2020) 45(6) *Austral Ecology* 731.

⁴³ Reside et al (n 18); James et al (n 17).

B *The Effect of Changing Wildfire Regimes on Wetland Services*

Individual fire events are relatively common in the Australian landscape and many ecosystems, including wetland ecosystems, have adapted to occasional burning. In fact, restoring indigenous fire practices has been a crucial restoration practice for wetlands in Kakadu National Park.⁴⁴ The 2019–20 Australian fires were different. Unusual in their intensity and scale, they decimated species ranges and will almost certainly have caused species extinctions.⁴⁵ However, in the longer term, it is the combination of repeated and more intense fires — fire regimes rather than events — that will have the largest impact on species and ecosystems.⁴⁶ Fire regimes are ‘the spatial and temporal patterning’ of recurring fires, including the history of burning across a landscape, intervals between fire events, the seasons in which fires have burned, and their length and the intensity of a fire in any given area.⁴⁷

There is clear evidence that conditions for extreme wildfires are becoming more severe and common in Australia.⁴⁸ The season for extreme fire danger is also becoming longer, extending into ‘shoulder periods’ in autumn and spring and reducing opportunities for planned and controlled burns to reduce fuel loads.⁴⁹ The Climate Council reported recently that, globally, the fire weather season extended by nearly 19 per cent between 1979 and 2013.⁵⁰ Each of these trends underpin a significant shift in the character of fire regimes that we can expect in future, and their likely impact on wetland ecosystems and their services. Indeed, depending on the rate and magnitude of climate change, changing fire regimes present a potentially existential threat to some wetland ecosystems.⁵¹

While the implications of wildfire for wetlands are complex, changing fire regimes will likely have negative impacts on wetlands, decimating species populations and habitat and disrupting ecological interactions and the provision

⁴⁴ Sandra McGregor et al, ‘Indigenous Wetland Burning: Conserving Natural and Cultural Resources in Australia’s World Heritage–Listed Kakadu National Park’ (2010) 38(6) *Human Ecology* 721, 723–4.

⁴⁵ Lily van Eeden et al, *Australia’s 2019–20 Bushfires: The Wildlife Toll* (Report, WWF Australia, 2020).

⁴⁶ Richard J Williams et al, *Interactions between Climate Change, Fire Regimes and Biodiversity in Australia: A Preliminary Assessment* (Report, Australian Government Department of Climate Change and Department of the Environment, Water, Heritage and the Arts, 2009) 14.

⁴⁷ *Ibid.*

⁴⁸ Reisinger et al (n 25) 1381, describing a projected ‘increase in days with very high and extreme fire danger index by 2–30% (2020), 5–100% (2050)’.

⁴⁹ Rebecca MB Harris et al, ‘An Assessment of the Viability of Prescribed Burning as a Management Tool under a Changing Climate: A Tasmanian Case Study’ in M Rumsewicz (ed), *Research Forum 2017: Proceedings from a Research Forum* (Bushfire and Natural Hazards CRC, 2017) 48.

⁵⁰ Lesley Hughes and Jacqui Fenwick, *The Burning Issue: Climate Change and the Australian Bushfire Threat* (Report, Climate Council, 2015).

⁵¹ Reisinger et al (n 25) 1375.

of ecosystem services.⁵² The IPCC notes that '[s]ignificant local and global losses of species, functional diversity, and ecosystem services, and large-scale changes in ecological communities, are anticipated' as a result of extreme events, including wildfire.⁵³ This is borne out in the early evidence from the 2019–20 wildfires in Australia, where 30.38 million hectares were burned.⁵⁴ Direct impacts from these fires include the destruction of more than 30 per cent of the habitat of 70 different species (21 of which are threatened species),⁵⁵ and a staggering three billion individual vertebrates are estimated to have been killed or displaced, including mammals, reptiles, birds and amphibians.⁵⁶ Direct impacts from extreme fire can also affect habitat and climate control services by, for example, raising water temperatures to extreme levels. The Black Saturday fires in Victoria in 2008 caused the water in at least one stream to boil.⁵⁷ Fires can also destroy soil bacteria and micro and invertebrate fauna, disrupting food webs and other provisioning services, as well as burning native wetland plants and destroying their roots, disrupting regulating services and severely delaying or preventing wetland recovery.

Fires also have indirect impacts on wetlands, including by exacerbating existing stressors. For example, young trees and vegetation regrowth use far more water than long-established forests. As climate change reduces average rainfall and increases evaporation rates, vegetation re-growth after fire will further reduce the proportion of run-off that reaches catchments to replenish wetland ecosystems.⁵⁸ Invasive species or pathogens may also be introduced to sensitive and remote wetland areas, for example, if contaminated water is dumped in an aerial delivery onto a fire or introduced to an area on fire-fighting equipment.

Fires also indirectly affect water quality, with rain washing ash, dust and fire retardant into waterways and wetlands after a fire. 'Sediment slugs' have been observed flowing down waterways after fire, suffocating freshwater fishes and other species and affecting water flows.⁵⁹ Suspended sediments can severely

⁵² Williams et al (n 46).

⁵³ Reisinger et al (n 25) 1387.

⁵⁴ David Bowman et al, 'Wildfires: Australia Needs National Monitoring Agency' (2020) 584(7820) *Nature* 188.

⁵⁵ Ward et al (n 2).

⁵⁶ van Eeden et al (n 45).

⁵⁷ J Khan, 'Our Drinking Water, Rivers and Fish Will All Feel the Impact of Bushfires, Experts Warn', *ABC Science* (online, 9 January 2020) <<https://www.abc.net.au/news/science/2020-01-09/freshwater-ecosystems-water-catchment-bushfire-impact/11850826>>.

⁵⁸ NE Marcar et al, *Predicting the Hydrological Impacts of Bushfire and Climate Change in Forested Catchments of the River Murray Uplands: A Review* (CSIRO, 2006).

⁵⁹ See, eg, Paul McInerney et al, 'The Sweet Relief of Rain after Bushfires Threatens Disaster for Our Rivers', *The Conversation* (online, 12 January 2020); Jason Alexandra and C Max Finlayson, 'Floods

impede services such as water purification, habitat provision and the capacity for wetlands to manage erosion and sediments and filter nutrients and pollution.⁶⁰ Carbon sequestration services can also be compromised when wetlands are damaged by fire, although carbon cycles may be even more significantly affected by carbon releases from wetlands as a result of burning, especially in peatlands where fires can burn for months or even years.⁶¹

Changing fire regimes in the Macquarie Marshes are interacting with drought and unsustainable upstream water uses, which have shifted the system from a semi-permanent to an ephemeral wetland.⁶² The October 2019 fire burned 3,000 hectares of the Macquarie Marshes Ramsar site, including 90 per cent of the wetland's main reed bed and potentially burning the reeds' root systems, which were not protected by wet mud as they have been in previous fire seasons.⁶³ The latest fire plan for the Macquarie Marshes notes that vegetation fire thresholds in large parts of the Ramsar site have now been exceeded and are categorised as 'Too Frequently Burnt'.⁶⁴ Other parts of the site are listed as 'Vulnerable to Frequent Fire' and will become 'Too Frequently Burnt' if they burn again in 2020–21.⁶⁵ Management zones require that both categories of vegetation in the Ramsar site should be protected from fire 'as far as possible'.⁶⁶

Emerging fire regimes present a far-greater threat to wetland ecosystems and their services than they have in the past because they combine increased exposure to wildfire events, re-burning after shorter periods of time, and a reduced likelihood of rainfall conditions that would support wetland replenishment and restoration, post-fire. This discussion provides a striking example of a broader challenge for conservation laws, about how best to anticipate and respond to the increasing likelihood of ecological transformation.

after Bushfires: Rapid Responses for Reducing Impacts of Sediment, Ash, and Nutrient Slugs' (2020) 24(1) *Australasian Journal of Water Resources* 9.

⁶⁰ Reisinger et al (n 25) 1389; Alexandra and Finlayson (n 59).

⁶¹ William R Moomaw et al, 'Wetlands in a Changing Climate: Science, Policy and Management' (2018) 38(2) *Wetlands* 183.

⁶² New South Wales Office of Environment and Heritage, *Macquarie Marshes Ramsar Site: Article 3.2 Response Strategy* (2013) ('NSW OEH').

⁶³ Davies (n 1), reporting Professor Richard Kingsford, Director of the Centre for Ecosystem Science at the University of New South Wales; New South Wales Parks and Wildlife Service, *Fire Management Strategy 2020–2025 for the Macquarie Marshes Nature Reserve* (March 2020) ('Fire Management Strategy').

⁶⁴ Fire Management Strategy (n 63).

⁶⁵ Ibid.

⁶⁶ Ibid.

IV LAW AND PRACTICE FOR RESTORING WETLAND ECOSYSTEM SERVICES AFTER WILDFIRE

Many Australian wetlands have already been degraded by unsustainable water extractions and extended drought, and the climate impacts described above will both increase and complicate the need for restoration in future. While ecological restoration seeks to reverse ecosystem degradation and regain a system's ecological functionality,⁶⁷ adaptation-oriented restoration seeks more than reinstating past ecological functions and returning to a past state.⁶⁸ Instead, adaptive restoration acknowledges the inevitability of changing ecological and climatic baselines and accepts that healthy ecosystems may need to rely on novel species assemblages to build climate resilience in wetlands and across broader landscapes. Wetland restoration can reduce the risks and impacts of extreme events such as floods, droughts and fire while also fostering adaptive capacity in the face of ongoing change.⁶⁹ For example, riparian revegetation projects can improve the health of freshwater species and the habitat value of river and wetland systems, while also moderating future increases in water temperatures.⁷⁰ The discussion below provides an overview of the ways that existing legal frameworks facilitate wetland restoration, and the weaknesses of these laws, in their current form, for facilitating restoration of ecosystem services as the climate changes.

A Implementing the Ramsar Convention in Australian law

The *Convention on Wetlands of International Importance especially as Waterfowl Habitat* ('Ramsar Convention') is the primary international legal instrument for conserving, managing and restoring wetland ecosystems.⁷¹ The Convention

⁶⁷ International Union for Conservation of Nature, 'UN Elevates Action on Ecosystem Restoration — IUCN Is Ready' (Web Page, 6 March 2020) <<https://www.iucn.org/news/forests/201903/un-elevates-action-ecosystem-restoration-iucn-ready>>.

⁶⁸ See Phillipa C McCormack, 'Reforming Restoration Law to Support Climate Change Adaptation' in Afshin Akhtar-Khavari and Benjamin J Richardson (eds), *Ecological Restoration Law: Concepts and Case Studies* (Routledge, 2019) 265.

⁶⁹ World Summit on Sustainable Development, *Plan of Implementation* (nd) 37(d), <https://www.ramsar.org/sites/default/files/documents/pdf/res/key_res_viii_16_e.pdf>.

⁷⁰ See Nicole E Heller and Erika S Zavaleta, 'Biodiversity Management in the Face of Climate Change: A Review of 22 Years of Recommendations' (2009) 14,2(1) *Biological Conservation* 14, and references therein.

⁷¹ Preamble, *Convention on Wetlands of International Importance especially as Waterfowl Habitat*, opened for signature 2 February 1971, 996 UNTS 246 (entered into force 21 December 1975) ('Ramsar Convention').

recognises the importance of wetland ecosystem services, including ‘as regulators of water regimes and as habitats supporting a characteristic flora and fauna, especially waterfowl’.⁷² Parties to the Convention must report changes to the ecological character of wetlands listed under the Convention, including changes to ‘the combination of ecosystem components, processes, benefits and services that characterise a wetland at a given point in time’, and must seek to restore the ecological character of degraded wetlands.⁷³

International guidance on the focus of ecological restoration, including under the *Ramsar Convention*, has been reframed in recent years to acknowledge the fact that ‘fully restoring an ecosystem to its original state is increasingly challenging and may not always be achievable’.⁷⁴ Under the *Ramsar Convention*, a listed site may be downsized or delisted due to unpreventable wetland loss or deterioration,⁷⁵ but only if it is impossible to maintain or restore its character. Guidance under the Convention explains that ‘unpreventable wetland loss or deterioration’ must be mitigated and, if the change is irreversible, compensation measures are required, such as an offset within the region of the wetland or as close to ‘like-for-like’ as possible.⁷⁶

The *Ramsar Convention’s* unusual recognition of the importance of ecosystem services has been translated into domestic legal frameworks in Australia, creating some of the few legal tools available to directly recognise, protect and restore ecosystem services. To meet Australia’s international obligations under the *Ramsar Convention*, the national *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (‘EPBC Act’) facilitates site listings under the *Ramsar Convention* and requires ecological character descriptions to inform site-management and planning. Ecological character descriptions must describe the wetland system and its components, along with short- and long-term threats and pressures, providing rigorous recommendations for restoring and maintaining

⁷² Ibid.

⁷³ Ibid arts 3(2), 8(2)(c).

⁷⁴ ‘Ecological restoration’ is also an explicit target under the *Convention on Biological Diversity*, opened for signature 5 June 1992, 1760 UNTS 69 (entered into force 29 December 1993). See Conference of the Parties to the Convention on Biological Diversity, *Decision of the COP in its Twelfth Meeting, Held in Pyeongchang from 6–17 October 2014 — Ecosystem Conservation and Restoration*, UN Doc UNEP/CBD/COP/DEC/XII/19 (17 October 2014); *Decision of the COP in its Eleventh Meeting, Held in Hyderabad from 8–19 October 2012 — Ecosystem Restoration*, UN Doc UNEP/CBD/COP/DEC/XI/16 (5 December 2012).

⁷⁵ Jamie Pittock et al, ‘Changing Character: The Ramsar Convention on Wetlands and Climate Change in the Murray–Darling Basin, Australia’ (2010) 27(6) *Environmental and Planning Law Journal* 401.

⁷⁶ See *Decision of the COP in its Eighth Meeting, Held in Valencia from 18–26 November 2002 — General Guidance for Interpreting ‘Urgent National Interests’ under Article 2.5 of the Convention and Considering Compensation under Article 4.2*, Resolution VIII.20 (26 November 2002), in which compensation may include offsets for the wetland within the same region or as close to a ‘like-for-like’ as possible.

ecological components, processes and resilience.⁷⁷ Ecological character descriptions explicitly assess the ecosystem services provided by Ramsar sites, and must detail both the ‘Ecosystem benefits and services’ that most strongly influence the ecological character of the Ramsar site and the ‘Limits of Acceptable Change’ (beyond natural variability) for those benefits and services.⁷⁸

Regulations under the *EPBC Act* set out Ramsar Management Principles that guide planning to maintain the ecological character of a wetland.⁷⁹ The Regulations do not mention ecosystem services but include, as a general principle, the need to maintain the ‘natural properties of the ecosystem’, including ‘for the benefit of humanity’.⁸⁰ The Regulations do not provide any guidance about restoration in wetlands beyond requiring that the management plan for each Ramsar site identifies whether restoration is needed (at the time the plan is prepared) and, if so, explain how the plan provides for that restoration.⁸¹

National guidelines also support implementing the *Ramsar Convention*, with directions about nominating sites, describing and mapping their boundaries and ecological character, and notifying the Ramsar Secretariat of a change in ecological character (‘Article 3.2 notification’).⁸² The national guidelines indicate that change to the ecological character of a site that is beyond acceptable limits may become apparent for ecosystem *processes* before it is apparent for ecosystem *services*, due to lag effects. Future impacts on ecosystem services at a site may nevertheless underpin an Article 3.2 notification on the basis that the site’s ecological character is ‘likely to change’.⁸³ In the case of wildfire, if burning causes or threatens to cause changes to a wetland’s ecological character that are beyond

⁷⁷ See, eg, New South Wales Office of Environment and Heritage, *Macquarie Marshes Ramsar Site Ecological Character Description* (Report, 2012) 2, 4.

⁷⁸ Department of the Environment, Water, Heritage and the Arts, *National Framework and Guidance for Describing the Ecological Character of Australia’s Ramsar Wetlands* (Report, 2008) 12, 19–20, <<http://www.environment.gov.au/system/files/resources/6d7408dc-2519-4294-9820-f7b2284816dd/files/module-2-framework.pdf>>.

⁷⁹ *Environment Protection and Biodiversity Conservation Act 1999* (Cth) s 335 (‘*EPBC Act*’), and *Environment Protection and Biodiversity Conservation Regulations 2000* (Cth) (‘*EPBC Regs*’) reg 10.02, sch 6, cl 1.01(a) and (b); the Minister ‘must make plans’ for Ramsar wetlands wholly located within Commonwealth areas and must *try* to prepare and implement management plans for other wetlands, in cooperation with states and territories: *EPBC Act* ss 328(1), 333(2).

⁸⁰ *EPBC Regs* sch 6, cl 1.01(a) and (b)(ii).

⁸¹ *Ibid* cl 2.02(f) and (g).

⁸² Department of Agriculture, Water and the Environment, *Australian National Guidelines for Ramsar Wetlands — Implementing the Ramsar Convention in Australia* (Web Page) <<https://www.environment.gov.au/water/wetlands/ramsar/australian-national-guidelines>>. This web page lists the multiple ‘modules’ or topic-specific guidelines (eg, below n 83) developed by the Australian government to support implementation of the Ramsar Convention.

⁸³ Department of the Environment, Water, Heritage and the Arts, *National Guidelines for Notifying Change in Ecological Character of Australian Ramsar Sites (Article 3.2)* (2009) (‘*Article 3.2 Guidelines*’) 6.

the specified Limits of Acceptable Change, this national statutory framework requires — at least at face value — that the Australian Government notify the Ramsar Secretariat and undertake planning and restoration activities to restore ‘critical’ ecosystem services,⁸⁴ which are those services that are most important to its ecological character.

Despite widespread recognition that climate change will negatively affect Ramsar wetlands,⁸⁵ the Australian Government’s national guidelines explain that an Article 3.2 notification will only be lodged with the Secretariat for human-induced changes to a wetland’s ecological character, not for changes principally caused by climate change.⁸⁶ Separating out human impacts from other drivers of change is complex, particularly where natural events such as floods, fires and droughts interact with human activities in a catchment, such as water extraction. Pittock and colleagues have argued strongly that climate change is human-induced and that climate-driven changes to a Ramsar site’s ecological character should be notified,⁸⁷ but there is no indication, at least at present, that the government intends to change its approach.

In practice, Article 3.2 notifications can drive climate-adaptive restoration planning and action in a wetland. For example, in July 2009, the Australian Government lodged an Article 3.2 notification for a likely change in ecological character in the NSW Macquarie Marshes. The notification was based on changes in water management and availability that had shifted the wetland from a semi-permanent to an ephemeral system.⁸⁸ Restoration actions taken under a resulting management strategy, along with two years of flooding rain, did improve the wetland against some criteria such as the presence of waterbirds and wetland vegetation.⁸⁹ However, years of drought followed, and ongoing reductions in flows from agricultural offtakes upstream left the marshes vulnerable. After the 2019–20 fires, the national Wildlife and Threatened Species Bushfire Recovery Expert Panel has targeted the Macquarie Marshes Ramsar site for detailed assessment to determine whether those fires have caused another notifiable change to the wetland’s ecological character.⁹⁰

It is not clear from the *EPBC Act*, Regulations or national guidelines how the Australian government would respond if climate-driven changes to wildfire

⁸⁴ Ibid 7.

⁸⁵ *Decision of the COP in its Tenth Meeting, Held in Changwon from 28 October–4 November 2008 — Climate Change and Wetlands*, Resolution X.24 (4 November 2008).

⁸⁶ Article 3.2 Guidelines (n 83) 8; Pittock et al (n 75).

⁸⁷ Pittock et al (n 75).

⁸⁸ NSW OEH (n 62).

⁸⁹ Ibid.

⁹⁰ Along with the Gwydir Wetlands and Gippsland Lakes Ramsar sites: Wildlife and Threatened Species Bushfire Recovery Expert Panel, *Communiqué* (online, 17 April 2020) <<https://www.environment.gov.au/system/files/pages/effd94e2-00fc-4e4b-8692-941f90f5ad8c/files/communique-17apr2020.pdf>>.

regimes transformed a Ramsar wetland towards an ecosystem state other than a wetland or caused the complete collapse of its ecosystem services. Guidance under the *Ramsar Convention* indicates that it would no longer qualify for continued listing, but the Australian legal framework does not describe the criteria against which that decision would be made and it is unclear how the *Ramsar Convention's* compensatory measures would be implemented or enforced.

B *Protected Area Management Laws*

Australia's protected area laws establish a framework for creating and managing protected areas. Australian protected area laws typically seek to conserve biodiversity, ecosystem processes, landscapes and natural features such as rivers and waterfalls.⁹¹ While these statutes do not explicitly protect 'ecosystem services', their overarching goals directly protect some supporting services and particularly biodiversity conservation. Protected area laws also protect cultural services in the form of sites and places of cultural significance to Traditional Owners, as well as places for scientific research and recreation.⁹² Protected area laws also implicitly protect other ecosystem services. For example, these laws may conserve regulating services such as protecting against soil erosion and maintaining hydrological regimes by protecting rivers and wetland systems and their functions.⁹³ At the same time, these laws often explicitly *exclude* many provisioning services such as firewood collection, and agricultural, commercial and industrial resource uses within protected areas.⁹⁴

Some protected area statutes include explicit restoration obligations, though none directly connect restoration with the concept of ecosystem services. For example, a person may be required to remediate a protected area if their actions have damaged that area.⁹⁵ Parks agencies may also be required to, for example:

⁹¹ See, eg, *National Parks and Wildlife Act 1974* (NSW) s 2A(1)(a); *Nature Conservation Act 1992* (Qld) s 5; *Nature Conservation Act 2002* (Tas) sch 1.

⁹² See, eg, *Nature Conservation Act 1992* (Qld) s 5(f), 21(1)(c); *Nature Conservation Act 2002* (Tas) sch 1, column 3. The *Crown Land Management Act 2009* (SA) goes somewhat further, declaring that principles of management under the Act include environmental protection being managed in a way that enables 'communities to provide for their economic, social and physical well-being and for their health and safety while...safeguarding the life-supporting capacity of air, water, land and ecosystems', s 5(2)(a)(ii).

⁹³ See, eg, *Nature Conservation Act 2002* (Tas) sch 1, cl 1(g); *National Parks and Wildlife Act 1974* (NSW) s 2A(1).

⁹⁴ See, eg, *Wilderness Protection Act 1992* (SA); *National Parks and Wildlife Act 1974* (NSW) s 41.

⁹⁵ *Crown Land Management Act 2009* (SA) s 57.

protect the national park against, and rehabilitate the national park following, adverse impacts such as those of fire ... and soil erosion on the national park's natural and cultural values.⁹⁶

Protected area laws typically require that government agencies create management plans for publicly managed protected areas, identifying important ecological values and threats to them, as well as the management objectives and priorities for conserving those values.⁹⁷ Statutory management plans can define priority values and threats as issues that require more detailed planning. For example, the Tasmanian Wilderness World Heritage Area ('TWWHA') Management Plan describes changing fire regimes as a particular threat to wetland values in the area, including alpine wetlands, blanket bogs and peat mounds.⁹⁸ In response, the statutory plan requires subsidiary (non-statutory) plans for fire management and rehabilitation activities, among other things,⁹⁹ acknowledging that active interventions can, at least in some circumstances, 'help to boost natural recovery, limit damage and restore natural values'.¹⁰⁰ Statutory management plans may also direct particular forms of restoration in the event of damage to protected values (though again, not specifically directed to service provision). For example, the Macquarie Marshes fire management plan requires emergency rehabilitation after fire, to prevent erosion where vegetation has been cleared for new firebreaks, containment lines and access tracks.¹⁰¹ The way that these obligations are framed suggests that restoring ecosystem services is, if anything, no more than an incidental benefit from the restoration of other protected area values.

⁹⁶ *National Parks and Reserves Management Act 2002* (Tas) sch 1, cl 1(g). See also *National Parks Act 1975* (Vic) s 21D(6)(b).

⁹⁷ See, eg, *EPBC Act* s 316 (world heritage properties); *National Parks Act 1975* (Vic) s 17(2)(d); *National Parks and Reserves Management Act 2002* (Tas) s 20(2); *Conservation and Land Management Act 1984* (WA) s 54(1). Conservation tenure is not conveyed with a Ramsar site listing; rather, Ramsar sites are often overlaid by a Commonwealth, state or territory reserve. Private protected areas and Indigenous Protected Areas are not subject to statutory planning obligations, but approved management plans are prerequisites for government support.

⁹⁸ Department of Primary Industries, Parks, Water and Environment, *Tasmanian Wilderness World Heritage Area Management Plan* (2016) 119–121 ('TWWHA Management Plan'); JB Marsden-Smedley and JB Kirkpatrick, 'Fire Management in Tasmania's Wilderness World Heritage Area: Ecosystem Restoration Using Indigenous-Style Fire Regimes?' (2000) 1(3) *Ecological Management & Restoration* 195.

⁹⁹ See, eg, Tasmanian Parks and Wildlife Service, *Site and Rehabilitation Plan: Melaleuca, Southwest National Park* (2014) 14, noting fire as a primary threat to blanket bogs and peat mounds in the area and requiring careful monitoring of planned burn regimes.

¹⁰⁰ TWWHA Management Plan (n 98) 119, [5.2.7] ('Restoring and Rehabilitating Values').

¹⁰¹ See, eg, Macquarie Marshes Fire Management Strategy (n 63), which requires that '[d]rainage lines and channels disturbed by the construction of containment lines must be rehabilitated as soon as possible as part of the suppression operations'.

Protected area management in practice is incorporating new responses to fire in sensitive ecosystems though, to date, these responses are also not focused on protecting or restoring ecosystem services. For example, Bushfire Rapid Risk Assessments were first implemented in Australia in 2008 by United States Burned Area Emergency Response Teams deployed to fight the Black Saturday fires in Victoria.¹⁰² This emergency assessment tool has since been refined in cooperation with other Australian jurisdictions and is now regularly implemented to identify and minimise immediate and long-term risks to natural values after fire events, including through emergency rehabilitation.¹⁰³ Rapid Risk Assessment activities can help to minimise lost services through, for example, preventing large-scale erosion, but do not contribute to long-term threats to ecosystem functioning or services that benefit human communities.

While statutory protected area management planning is well-equipped to support some cultural services such as recreation, research and an appreciation of natural features and views, this legal tool has more limited capacity to facilitate more complex services such as regulating services for climate and pollution control. Limitations include that management plans only apply within protected area boundaries, which can be an impediment to effectively restoring lost or degraded wetland ecosystem services that rely on tributaries across a broader catchment.¹⁰⁴ For example, management planning cannot protect against reduced flows into a catchment as a result of drying trends, or from increased offtakes upstream for agriculture or human needs. This is a well-recognised challenge for wetland conservation and will increase in significance as the climate changes.¹⁰⁵

Protected area laws do not provide guidance on the status of an area if an extreme event triggers its transformation from, for example, a wetland ecosystem towards a novel ecological state. In some cases, transforming ecosystems will continue to be protected — such as alpine wetlands located far from industrial and urban centres in the heart of the TWWHA. Other sites, such as

¹⁰² TCCO (n 3) 39–40.

¹⁰³ Ibid. Rapid risk and damage assessments have been deployed in fighting fires in the TWWHA in 2013, 2016 and 2019 and are incorporated into the Tasmanian Emergency Management Arrangements under the *Emergency Management Act 2006* (Tas).

¹⁰⁴ Although there is some capacity to manage broader environmental flows into Ramsar wetlands to ensure their ecological character, for example through Environmental Impact Assessment processes under the *EPBC Act*. See Jamie Pittock, 'Murray–Darling Basin: Conservation and Law' in C Finlayson et al (eds) *The Wetland Book* (Springer, 2016) 1.

¹⁰⁵ Jamie Pittock et al, 'Managing Freshwater, River, Wetland and Estuarine Protected Areas' in Graeme L Worboys et al (eds), *Protected Area Governance and Management* (ANU Press, 2016) 569; Robin Abell et al, 'Looking Beyond the Fenceline: Assessing Protection Gaps for the World's Rivers' (2016) 10(4) *Conservation Letters* 384.

fire-affected wetlands in the Murray–Darling Basin, may be the subject of calls for access to develop (eg for agriculture) or to be ‘swapped’ for more diverse, resilient or healthy ecosystems. Protected area legislation typically requires a declaration of revocation to be approved by both houses of Parliament before a reserve’s conservation status is revoked,¹⁰⁶ but there is little-to-no legal guidance about the level of consultation required before a protected area can be downgraded or revoked or on the scientific or other considerations that should be taken into account.¹⁰⁷ The process is even more opaque for revoking conservation covenants on private land. These legal gaps in planning for ecosystem transformation will become far more apparent as climate change causes rapid, simultaneous and widespread ecological change, and as ecosystem services change more rapidly and are lost.

C *Threatened Species and Habitat Conservation Laws*

In addition to protecting Ramsar wetlands, the *EPBC Act* also implements Australia’s international obligations for protecting migratory birds and threatened species and ecological communities, including by empowering the national Environment Minister to make recovery plans for any species or ecological community threatened with extinction.¹⁰⁸

Recovery plans are statutory instruments that list the actions necessary to stop species and ecological community declines, support their recovery, and maximise their long-term chances of survival,¹⁰⁹ and may include habitat restoration obligations. For example, the interim recovery plan for the critically endangered *Tumulus* (organic mound) springs of the Western Australia Swan Coastal Plain proposes to reverse the degraded status of the ecological community’s habitat and sustain its hydrological regimes by rehabilitating

¹⁰⁶ See, eg, *Nature Conservation Act (Tas)* s 21(1), (4); *EPBC Act* s 350; cf *Legislation Act 2001 (ACT)* s 46, which provides that the ‘power to make a declaration includes the power to amend or repeal the declaration. The power to amend or repeal the declaration is exercisable in the same way, and subject to the same conditions, as the power to make the declaration.’

¹⁰⁷ For example, *EPBC Act* s 351 requires a comprehensive report prior to proclaiming a reserve, including an invitation for public comment, but for revocation, simply publication of a notice identifying the boundaries of the relevant Commonwealth reserve.

¹⁰⁸ The *EPBC Act* implements Australia’s obligations under, for example, the *Convention on the Conservation of Migratory Species of Wild Animals*, opened for signature 23 June 1979, 1651 UNTS 333 (entered into force 1 November 1983), and bi-lateral migratory bird conservation agreements such as the *Japan Australia Migratory Bird Agreement*, opened for signature 6 February 1974, [1981] ATS 6 (entered into force 30 April 1981).

¹⁰⁹ *EPBC Act* s 270.

'recharge catchment zones' and replanting adjacent areas with native wetland shrubs.¹¹⁰

Implementing recovery plans for species and ecological communities may contribute to restoring ecosystem services, particularly if the focal species or community plays a key role in service provision. Mangroves are a ubiquitous example because the keystone species forms mangrove forests that provide a host of ecosystem services such as food and fuel; supporting services such as fish nurseries and other aquatic habitat; and regulating services such as managing hazards from storm surges and sea level rise.¹¹¹ Promoting the recovery of protected mangrove forests will have clear restoration outcomes for the ecosystem services that those forests provide. However, as with other laws described above, ecosystem services that are restored through activities under a species or ecological community recovery plan will usually be an incidental (though desirable) outcome of those activities.

Recovery plans are a limited legal tool for restoration in general, let alone for restoring ecosystem services. Many threatened species and ecological communities are not keystone species like mangroves and implementing recovery plans for them will not restore broader ecosystem services. Recovery plans are also restricted to individual species or communities and not embedded in a broader, ecological context. However, their greatest weakness is that recovery plans are discretionary.¹¹² The Commonwealth Minister is not obliged to prepare recovery plans for threatened species and communities and less than half of nationally listed species and communities have a recovery plan.¹¹³ Of those plans that do exist, many are out-of-date, under-funded and poorly implemented, and few impose any prescriptive measures to protect or restore habitat, let alone facilitate the restoration or recovery of ecosystem services to which those species and communities contribute.¹¹⁴

State legislation also provides for the protection of threatened species and ecological communities and their habitat. For example, the Tasmanian *Nature Conservation Act 2002* lists wetlands and *Sphagnum* peatlands as threatened native vegetation communities that the state Environment Minister can protect,

¹¹⁰ Western Australian Government, *Community of Tumulus (Organic Mound) Springs of the Swan Coastal Plain Interim Recovery Plan No 198* (2006) 12, 24, adopted in 2012 as the federal recovery plan under s 269A of the *EPBC Act*.

¹¹¹ Bell-James et al (n 11).

¹¹² *EPBC Act* s 269AA.

¹¹³ Recovery plans are operationalised through a prohibition on the Minister taking any action that contravenes a recovery plan: *EPBC Act* s 268. See Australian Conservation Foundation (ACF), Birdlife Australia and Environmental Justice Australia, *Recovery Planning: Restoring Life to Our Threatened Species* (2015) 6, 8.

¹¹⁴ ACF et al (n 113).

including on private land through conservation covenants with landowners.¹¹⁵ The Tasmanian Act imposes financial penalties for breaching a conservation covenant by destroying, for example, a *Sphagnum* peatland, but does not require any form of ecological restoration, nor does it recognise connections between impacts on a peatland and flow-on impacts on the ecosystem services they provide, such as climate regulation, water filtration or nutrient cycling.¹¹⁶

The *Biodiversity Conservation Act 2016* (NSW) takes a broader approach, protecting (uniquely in Australia) climate refuges,¹¹⁷ along with areas of ‘outstanding biodiversity value’ if, among other things, they make a significant contribution to the persistence of ecological processes or ecological integrity.¹¹⁸ Both of these values protected under the NSW Act could readily encompass the protection of at least some wetland ecosystem services. The NSW Act does not recognise that potential role, though, and in practice it operates similarly to other state and territory conservation laws, imposing rehabilitation obligations for human-caused environmental damage¹¹⁹ and penalties or ‘make good’ orders for harming, among other things, a declared area of outstanding biodiversity value.¹²⁰

In the absence of specific guidance for implementation, or an ecosystem services framework into which species and habitat conservation could be embedded, the conservation laws described in this section offer very limited support for restoring and sustaining ecosystem services.

D *Natural Resource Management Laws*

There are few obligations to protect or restore important wetland systems and their services outside of Australia’s conservation-specific legal frameworks. One important exception is the scheme for managing ‘environmental flows’ in the Murray–Darling Basin. The *Water Act 2007* (Cth) establishes the Murray–Darling Basin Authority and the Commonwealth Environmental Water Holder to manage flows in the Basin and regulate the balance between competing environmental, economic and social objectives for water use.¹²¹ The *Water Act* includes an unusual

¹¹⁵ See *Nature Conservation Act 2002* (Tas) pt 5, sch 3A, although the extent to which conservation covenants are imposed on landowners to protect threatened native vegetation communities is unclear.

¹¹⁶ *Nature Conservation Act 2002* (Tas) s 46.

¹¹⁷ *Ibid* cl 3.2(2).

¹¹⁸ *Biodiversity Conservation Act 2016* (NSW) cl 3.2(1).

¹¹⁹ Although the Act relies heavily on a Biodiversity Offsetting scheme: *ibid* pt 6.

¹²⁰ *Ibid* cl 13.20(1).

¹²¹ While these authorities were intended to improve the health of freshwater ecosystems in the Basin, they operate in a particularly politically charged context and have been limited in their capacity to

statutory object, to ‘protect, restore and provide for the *ecological values and ecosystem services* of the Murray–Darling Basin’,¹²² emphasising ecological health and the services that the water resources of the Basin provide to humans. This focus probably reflects the complexity of the regulatory environment, which seeks to find an (as yet elusive) balance between environmental flows and industrial agriculture and human communities located along the full length of this transboundary water system. Nevertheless, the *Water Act* is an important example of statutory recognition of ecosystem services, seeking to protect ecosystem services as an environmental asset of the Murray–Darling Basin and a key indicator of the health of Basin water resources. It is disappointing that despite the promise of the objects in the *Water Act* and the powers granted to the Basin Authority and Environmental Water Holder, balancing social, economic and ecological outcomes has proven difficult and, in practice, the Murray–Darling Basin remains the site of many of the most-stressed freshwater ecosystems on the continent.

A small number of natural resource management laws support active restoration without a human-caused damage ‘trigger’, which creates opportunities for their use in restoring ecosystem services after climate-driven events such as wildfire. For example, the *Landscape South Australia Act 2019* (SA) (*‘Landscape Act’*) promotes restoration of ecological systems and processes that have been lost or degraded, through integrated management of natural resources at landscape scales. Landscapes are defined to include natural resources and features as well as the *‘human values and uses related to interaction with the environment’*.¹²³ The *Landscape Act* empowers the Minister to enter into management agreements with private landowners for, among other things, ‘the conservation ... enhancement, restoration or rehabilitation of any natural resources’.¹²⁴ While there is no explicit reference to ecosystem services, this legislation takes an unusually broad approach to natural resource management, recognising a range of *values and uses* for natural resources in South Australia. The *Landscape Act* relies on landowners to ‘opt in’ to its conservation and restoration goals, so there is no capacity to impose a consistent statutory definition of restoration that acknowledges the multiple ways that humans value and use the environment. The *Landscape Act* does, however, provide legal principles and tools

achieve positive environmental outcomes. See Jamie Pittock and C Max Finlayson, ‘Australia’s Murray–Darling Basin: Freshwater Ecosystem Conservation Options in an Era of Climate Change’ (2011) 62(3) *Marine and Freshwater Research* 232.

¹²² *Water Act 2007* (Cth) s 3(d)(ii) (emphasis added).

¹²³ *Landscape South Australia Act 2019* (SA) s 7(1)(emphasis added).

¹²⁴ *Landscape South Australia Act 2019* (SA) s 219(1)(a); see also *Conservation and Land Management Act 1984* (WA) s 33(1)(cc).

for incentivising restoration and an unusual capacity to direct restoration effort towards ecosystem services, as examples of both values and uses of the environment.¹²⁵

Voluntary mechanisms such as Landcare and Coastcare are another potential tool for engaging and empowering communities to engage in ecosystem services-focused restoration. Involving local communities in planning and executing restoration projects is widely recognised as a fundamental principle for achieving ecological restoration.¹²⁶ Local volunteer organisations have the advantage of bringing together local expertise and connection to ecosystems that provide services to them, and fostering and sustaining commitment to their protection over the long-term. At present, Landcare and Coastcare restoration projects tend to have limited capacity, resourcing and expertise to undertake the kind of large-scale or complex restoration involved in restoring wetland ecosystem services, but could facilitate local community engagement in such projects in future.

Practical legal mechanisms to generate environmental gains, other than liability for environmental harm, are otherwise absent from Australian conservation laws.¹²⁷ Given the climate change projections and implications described in Part III above, it is noteworthy that most legal frameworks for conservation and restoration provide so little guidance about the role and value of ecosystem services provided by wetlands, and no guidance about the status of wetlands (and other valuable natural areas) that *cannot* be restored to previous functional states after extreme events such as wildfire.

V LEGAL REFORM FOR RESTORING OR TRANSFORMING ECOSYSTEM SERVICES

There is growing evidence that wetland restoration projects can successfully restore wetland ecosystem services, but also that the task of restoring wetland functions and the services they provide to human communities is extremely

¹²⁵ Eg, *Landscape South Australia Act 2019* (SA) 'State Landscape Strategy' in pt 3, 'Landscape Priorities Fund' in s 93, and 'action plans' issued under pt 7.

¹²⁶ Katharine Suding et al 'Committing to Ecological Restoration' (2015) 348(6235) *Science* 638; Finlayson et al (n 6); Kyle Blount and Adrienne Kroepsch, 'Improving the Resilience of Water Resources after Wildfire through Collaborative Watershed Management: A Case Study from Colorado' (2019) 3(1) *Case Studies in the Environment* 1.

¹²⁷ Cf the Canadian *National Parks Act* (SC 2000, c32) s 8(2), which provides that 'the maintenance or restoration of *ecological integrity* ... shall be the first priority of the Minister administering the Act', as referenced in Australian Panel of Experts in Environmental Law, *The Foundations of Environmental Law Technical Paper 1: Goals, Objects, Principles and Norms* (APEEL, 2017) 40.

challenging. Nevertheless, existing conservation laws could, if fully implemented, improve the adaptive capacity of wetland systems and the services they provide, to changing wildfire regimes. Important strategies in existing laws include environmental flow regimes to supplement water arriving in wetlands in dry periods, and invasive species eradication that can, among other benefits, reduce the exposure of wetlands to non-native vegetation that exacerbates wildfire.¹²⁸ New approaches to implementing existing laws could also improve their effectiveness by, for example, prioritising critical habitat declarations for wetlands unharmed by fire, and protecting wetland ecosystems in new reserves that offer fire refuges and climate refugia.¹²⁹ Existing environmental laws have failed to arrest environmental decline in Australia, due in large part to serious shortfalls in funding, implementation, monitoring and enforcement,¹³⁰ and climate change is emerging as a far more complex threat for which existing laws are generally unprepared.¹³¹ It is in this context that the effect of wildfires on wetlands demands that we engage in a difficult conversation about how to choose between different goals and objectives for natural areas. In addition to rigorously implementing and enforcing existing laws, this Part proposes that legal objects and substantive and procedural legal frameworks will require reform to accommodate the certainty of transformational change and ecological loss.¹³²

A Practical Challenges for Restoring Wetland Ecosystem Services

There is growing evidence from around the world that wetland restoration projects can produce positive results, including successfully restoring ecosystem

¹²⁸ See, eg, Jenny Davis et al, *Climate Change Adaptation Guidelines for Arid Zone Aquatic Ecosystems and Freshwater Biodiversity* (National Climate Change Adaptation Research Facility, 2013) 22; Kristin Zouhar et al, *Wildland Fire in Ecosystems: Fire and Nonnative Invasive Plants* (US Department of Agriculture, 2008).

¹²⁹ James A Fitzsimons, 'Urgent Need to Use and Reform Critical Habitat Listing in Australian Legislation in Response to the Extensive 2019–2020 Bushfires' (2020) 37(2) *Environmental and Planning Law Journal* 143.

¹³⁰ Australian National Audit Office, *Referrals, Assessments and Approvals of Controlled Actions under the Environment Protection and Biodiversity Conservation Act 1999, Auditor-General Report No 47* (Report, 2020). For underfunding in Australia, see James E Watson et al, 'The Performance and Potential of Protected Areas' (2014) 515(7525) *Nature* 67, 69.

¹³¹ See, generally, the work of the Australian Panel of Experts on Environmental Law <<http://apeel.org.au/>>.

¹³² Saffron J O'Neill and John Handmer 'Responding to Bushfire Risk: The Need for Transformative Adaptation' (2012) 7(1) *Environmental Research Letters* 014018.

services.¹³³ For example, when bird species returned to restored Bangladeshi wetlands, they improved the economic benefits of ecotourism and fisheries;¹³⁴ and a wetland restoration in the Napa River Basin in California reduced both flood risk and damage, and improved water quality, property values, wildlife habitat and tourism in the region.¹³⁵

However, restoring ecosystem services faces serious practical hurdles, particularly in the context of climate change. The most fundamental hurdle, which is widely recognised in scientific and legal scholarship, is defining what climate change will mean for an ecosystem services restoration project to succeed.¹³⁶ That is, against what historical and ecological baseline conditions should restored services be measured? Should success be based on actions — such as replanting a full suite of a wetland's native vegetation communities or ensuring inundation in a particular year — or should it depend on outcomes, such as ecological processes occurring without human intervention and, in fact, providing services to human and ecological communities?¹³⁷ In some cases, efforts to restore wetland ecosystem services for climate adaptation, including to support human adaptive capacity, will achieve neither the ecosystem services goal nor ecological restoration outcomes.¹³⁸ Changed rainfall patterns and reduced river flows, warmer temperatures and more frequent extreme events may all undermine the possibility of 'returning' a wetland to a past state, and in some cases may make it difficult to restore a 'wetland' at all.

Other practical challenges include the complexity of interactions between the ecological components of a system and the diversity of ecological, legal, social and economic inputs, many of which cannot be controlled.¹³⁹ It may also take a long time for a restored wetland to provide, for example, habitat conditions suitable for water birds, and for those water birds to actually return, if they ever

¹³³ Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 'Chapter 2.2: Status and Trends – Nature' in Díaz et al (n 8) 90; Vanessa Reis et al, 'A Global Assessment of Inland Wetland Conservation Status' (2017) 67(6) *BioScience* 523.

¹³⁴ Reis et al (n 133).

¹³⁵ Ibid.

¹³⁶ See, eg, Suding et al (n 126); R Keller Kopf et al, 'Anthropocene Baselines: Assessing Change and Managing Biodiversity in Human-Dominated Aquatic Ecosystems' (2015) 65(8) *Bioscience* 798.

¹³⁷ On the importance of a clear and effective definition of ecological restoration in law and policy to 'support ecosystems and the people that depend on them' see, eg, Margaret A Palmer and JB Ruhl, 'Aligning Restoration Science and the Law to Sustain Ecological Infrastructure for the Future' (2015) 13(9) *Frontiers in Ecology and the Environment* 512.

¹³⁸ Suding et al (n 126) and references therein; on the difference between ecological and other forms of restoration in law, policy and practice, see Afshin Akhtar-Khavari and Benjamin J Richardson (eds), *Ecological Restoration Law: Concepts and Case Studies* (Routledge, 2019).

¹³⁹ See, generally, Society for Ecological Restoration Australasia, *National Standards for the Practice of Ecological Restoration in Australia* (2nd ed, 2017).

do. Both ecological complexity and time lags may mean that human intervention such as weeding or artificial watering will need to be sustained over long timeframes, or indefinitely, and even with ongoing active intervention, restoration of some wetland ecosystem services may face diminishing odds of long-term success.

B *Legal Objects and Goals Must Anticipate Change*

In Australia, as is the case elsewhere, conservation laws are often framed by ‘preservation-oriented’ goals, and underpinned by broad legal presumptions about nature remaining essentially unchanging over time.¹⁴⁰ There is widespread recognition that climate change raises significant challenges for these goals and presumptions, and that they must be reformed.¹⁴¹ There is, however, no consensus about the precise form that new legal goals should take.

Conservation scholarship has highlighted the need to shift the focus of these laws, policies and management practices as the climate changes, from ‘preventing change to managing inevitable change’.¹⁴² The *Biodiversity Conservation Act 2016* (NSW) is the first Australian conservation law to engage with that task to some degree, with an objects clause that specifically mentions climate change and its significance for conservation.¹⁴³ However, no Australian conservation law currently anticipates the growing need to recognise value in novel ecological functions and the new combinations of ecosystem services that they may provide. Similarly, legal protection for mixed native and non-native species assemblages or engineered forms of habitat are limited.¹⁴⁴ As a result,

¹⁴⁰ For a review of Australian conservation laws, see Phillipa C McCormack, ‘The Legislative Challenge of Facilitating Climate Change Adaptation for Biodiversity’ (2018) 92(7) *Australian Law Journal* 546. See also Arie Trouwborst, ‘International Nature Conservation Law and the Adaptation of Biodiversity to Climate Change’ (2009) 21(3) *Journal of Environmental Law* 419; Robin Kundis Craig, ‘“Stationarity is dead” — Long Live Transformation: Five Principles for Climate Change Adaptation Law’ (2010) 34(1) *Harvard Environmental Law Review* 9.

¹⁴¹ McCormack (n 140); Michael Dunlop et al, *Climate-Ready Conservation Objectives: A Scoping Study* (National Climate Change Adaptation Research Facility, 2013); Reisinger et al (n 25) 1391.

¹⁴² Dunlop et al (n 141); McCormack (n 140).

¹⁴³ *Biodiversity Conservation Act 2016* (NSW) cl 1.3(b), (d). This Act was the subject of a series of detailed issues papers and government consultation, including on the issue of climate change. See New South Wales Office of Environment and Heritage, *Biodiversity Legislation Review: Submissions Report* (Report, 2014) 6–11.

¹⁴⁴ Though they may find some protection in local government and private conservation initiatives, which are less strictly bound by definitions of ‘nativeness’ and ‘naturalness’. See, eg, the treatment of local biodiversity in Government Architect NSW, *Greener Places: An Urban Green Infrastructure Design Framework* (Draft 2020) <<https://www.governmentarchitect.nsw.gov.au/policies/greener-places>>.

there is limited capacity to develop clear restoration guidelines that include a focus on ecosystem services as environmental conditions change. The same is true for interventions that might facilitate more rapid ecosystem transformation, either to circumvent a less-desirable but highly likely future change or, for example, to engineer conditions to provide specific ecosystem services, such as habitat for species that have lost the entirety of their natural habitat in a fire.¹⁴⁵

In reforming statutory objects clauses, governments should also provide guidance about how to balance competing objects.¹⁴⁶ For example, maintaining the ‘naturalness’ of an ecosystem may need to give way to active intervention such as earthworks and artificial watering to sustain threatened wetland ecosystem services such as water purification for a city’s water supply. Similarly, protecting a threatened species in the wild may need to give way, if it loses *all* of its habitat in repeated wildfires, to a greater emphasis on conserving the species in a new location, where climatically suitable habitat exists or can be created. Climate change will also exacerbate conflicts between objects in different statutes, such as conserving native vegetation while also managing flammable vegetation and fuel loads under planning instruments.¹⁴⁷ These kinds of conflicts will need to be managed to avoid degrading or losing ecosystem services *in anticipation of fire*, as well as during fire events themselves.

C *New Legal Mechanisms Will Be Required*

Climate change will transform many wetland ecosystems, regardless of whether Australia’s legal frameworks are prepared or equipped for that outcome. In coming decades, some wetlands will be lost, others will change, and some may be sustained through active forms of intervention. As in any environmental management context, effective restoration will depend on clear goals and measures of success.¹⁴⁸ An issue that deserves much closer attention, then, is whether the primary goal of wetland restoration ought to be an ecological goal — ie to restore adaptive, resilient wetland ecosystems — or whether, as human communities are also forced to adapt to climate change, the primary goal for wetland restoration ought to be creating and sustaining ecosystem services that

¹⁴⁵ For a discussion about restoration, recovery and redefinition in marine areas: Melinda Ann Coleman et al, ‘Restore or Redefine: Future Trajectories for Restoration’ (2020) 7 *Frontiers in Marine Science* 237.

¹⁴⁶ McCormack (n 140).

¹⁴⁷ See, eg, Victoria’s Wildfire Management Overlay, discussed in Reisinger et al (n 25) 1408.

¹⁴⁸ Karel Prach et al, ‘A Primer on Choosing Goals and Indicators to Evaluate Ecological Restoration Success’ (2019) 27(5) *Restoration Ecology* 917; Jeffrey D Parrish et al, ‘Are We Conserving What We Say We Are? Measuring Ecological Integrity Within Protected Areas’ (2003) 53(9) *BioScience* 851.

benefit humans and facilitate human adaptation. In some cases, we may be able to chart a middle path, prioritising the restoration of functional ecosystems that also provide ecosystem services to human communities.¹⁴⁹ In other cases, decision-makers will be forced to choose between ecological and anthropocentric restoration goals. The remainder of this paper argues that decision-makers will need clearer statutory and policy guidance to make those decisions, and to balance trade-offs in ecological and human wellbeing.

The clearest opportunities for promoting both biodiversity and human adaptation through wetland restoration arise in the context of climate mitigation and negative emissions strategies. Wetlands will be less sensitive and vulnerable to changing wildfire regimes if the global community — including the Australian government — adopts and implements strong climate mitigation targets. Wetland restoration can contribute to climate mitigation targets through carbon trading schemes and especially blue-carbon abatement methodologies.¹⁵⁰ Restoration in this context can focus on facilitating wetland adaptation and conservation because restored, and constructed, wetlands can provide services such as carbon sequestration and climate mitigation while also providing biodiversity habitat and other provisioning and supporting ecosystem services.¹⁵¹ Wetland restoration can also contribute to negative emissions strategies by drawing carbon from the atmosphere and sequestering it in natural wetland carbon sinks.¹⁵²

Another context in which biodiversity and human adaptation needs may be mutually served through wetland restoration is in restoring ecosystem services outside of Ramsar sites and other protected areas. Bioregional and integrated catchment management planning tools in Commonwealth and state legislation¹⁵³

¹⁴⁹ Matthew J Colloff et al, 'Adaptation Services of Floodplains and Wetlands under Transformational Climate Change' (2016) 26(4) *Ecological Applications* 1003. On the issue of co-benefits in restoration or 'renewal', see David MJS Bowman et al, 'Renewal Ecology: Conservation for the Anthropocene' (2017) 25(5) *Restoration Ecology* 674.

¹⁵⁰ Australian Government Department of the Environment and Energy, *Wetlands Australia 31: Australian Government Initiatives for Blue Carbon*, <<https://www.environment.gov.au/water/wetlands/publications/wetlands-australia/national-wetlands-update-february-2019/govt-initiatives-blue-carbon>>; Karita Negandhi et al, 'Blue Carbon Potential of Coastal Wetland Restoration Varies with Inundation and Rainfall' (2019) 9 *Scientific Reports* 4368.

¹⁵¹ Serrano et al (n 16).

¹⁵² Negative emissions strategies seek to remove greenhouse gases from the atmosphere to reduce emissions to *below* zero. See, eg, Lisamarie Windham-Myers et al, 'Potential for Negative Emissions of Greenhouse Gases (CO₂, CH₄ and N₂O) through Coastal Peatland Re-Establishment: Novel Insights from High Frequency Flux Data at Meter and Kilometer Scales' (2018) 13(4) *Environmental Research Letters* 045005.

¹⁵³ See, eg, *EPBC Act* pt 12 (bioregional planning); *Catchment and Land Protection Act 1994* (Vic) s 27 (catchment plans).

suffer from limited implementation but, if appropriately resourced and implemented, could be used to recognise the significance of well-connected tributaries and catchments for wetland ecosystems and improve the provision of ecosystem services from a broader range of waterways and wetlands.¹⁵⁴ Adaptation-oriented catchment-scale management could empower managing authorities to prioritise wetland ecosystem services that are poorly managed under existing, often-siloed regulatory schemes. Services such as climate, water and natural hazard regulation, connectivity for freshwater biodiversity, and spiritual and cultural services such as traditional knowledge and burning practices in wetland ecosystems,¹⁵⁵ could be prioritised more effectively alongside economic water uses such as agricultural offtakes.¹⁵⁶ Funding limitations for restoration activities within and beyond the protected area estate could be alleviated by support for investment in green bonds to restore wetland ecosystem services, capitalising on institutional investors' growing interest in 'greening' investment portfolios and creating desperately needed new sources of funding for ambitious, adaptation-oriented restoration.¹⁵⁷

In some circumstances, biodiversity adaptation may need to be prioritised over restoring ecosystem services for human benefit. For example, restoring wetlands to provide climate refugia to vulnerable species and ecological communities will become an increasingly urgent strategy for reducing climate-driven species extinctions, including in the context of fire-sensitive and vulnerable wetland communities.¹⁵⁸ Refugia provide 'transitional havens' to buy time for species and ecological communities to adapt as the climate changes.¹⁵⁹ The US Forest Service has recognised this need, incorporating climate refugia projections into its restoration planning for areas that were affected by the 2014

¹⁵⁴ Freshwater connectivity and dispersal patterns are critical factors, including in allowing species to access refugia and recolonise unburned areas after extreme events such as wildfire, James et al (n 17).

¹⁵⁵ McGregor et al (n 44).

¹⁵⁶ Sustainability objectives that might otherwise have promoted regulating, supporting and cultural services under the *Water Act 2007* (Cth) have been undermined by political imperatives; but see Ministry for the Environment (New Zealand Aotearoa), *National Policy Statement for Freshwater Management 2020* (2020), which prioritises health and wellbeing of freshwater ecosystems over essential human needs and social, economic and cultural wellbeing (cl 2.1), and mandates restoration and improvement of degraded water bodies, including outside protected areas (cl 3.22(4)), to ensure ecosystem services can be sustained over the long term.

¹⁵⁷ Emma Herd, 'Institutional Investors Increasingly Taking Their Own Climate Action', *The Age* (online, 14 January 2020) <<https://www.smh.com.au/business/the-economy/institutional-investors-increasingly-taking-their-own-climate-action-20200114-p53raz.html>>.

¹⁵⁸ On the urgent need to identify and protect climate refugia generally, see Reside et al (n 18); Morelli et al (n 18).

¹⁵⁹ Morelli et al, 'Climate Change Refugia: Biodiversity in the Slow Lane' (2020) 18(5) *Frontiers in Ecology and the Environment* 228.

'King Fire' in California.¹⁶⁰ Protecting refugia will require strong legal instruments that effectively exclude human development from wetland refugia, incentives for public and private restoration efforts that restore or create refugial values,¹⁶¹ and legal mandates for restoring wetland habitats after extreme events such as fire.

In some cases, rigorously managed, adaptation-oriented offsets may be needed to conserve healthy refugia by allowing heavily damaged conservation areas to be converted to other uses. For example, where wetland ecosystem services are suddenly lost (eg to wildfire) or transformed over time (eg by drying and warming trends) and *cannot* be restored to a functioning state, it may be preferable to 'swap' such areas for newly protected, healthy wetlands that can provide refuge from future fires or other critical habitat.¹⁶² Rules for wetland offsets would need to be designed to achieve real offsets, with strong penalties and other enforcement tools for failing to achieve or maintain offset values. Offsetting should be a tool of absolute last resort — unavailable in respect of healthy wetland ecosystems — and lessons must be learned from the demonstrable failings of biodiversity offsetting laws, including failures in the mitigation hierarchy and the absence of climate considerations in offsetting calculations.¹⁶³

There is a great deal of work to be done in developing legitimate and rigorous priorities for wetland restoration, and the work will need diverse input, including from sociological, ecological, Traditional Owner, bioengineering and legal perspectives. In the meantime, and regardless of what priorities are ultimately set, there is an urgent need to improve procedural aspects of decision-making to better meet the challenges of climate change.

Procedural guidance will be crucial for enhancing the legitimacy and accountability of complex and controversial decisions about whether and when to intervene to restore ecosystem services. In particular, decision-makers will

¹⁶⁰ James H Thorne et al, 'Vegetation Refugia Can Inform Climate-Adaptive Land Management under Global Warming' (2020) 18(5) *Frontiers in Ecology and the Environment* 281.

¹⁶¹ Joseph L Ebersole et al, 'Managing Climate Refugia for Freshwater Fishes under an Expanding Human Footprint' (2020) 18(5) *Frontiers in Ecology and the Environment* 271, describing United States state and federal government efforts to integrate characteristics such as streamflow and water temperature to identify and evaluate potential climate-change refugia. See also Thorne et al (n 160).

¹⁶² See, eg, Nicholas Whipps, 'What Happens When Species Move but Reserves Do Not? Creating Climate-Adaptive Solutions to Climate Change' (2015) 66(2) *Hastings Law Journal* 557.

¹⁶³ Martine Maron et al, 'Faustian Bargains? Restoration Realities in the Context of Biodiversity Offset Policies' (2012) 155 *Biological Conservation* 141; Jan McDonald, Phillipa C McCormack and Anita Foerster, 'Promoting Resilience to Climate Change in Australian Conservation Law: The Case of Biodiversity Offsets' (2016) 39(4) *University of New South Wales Law Journal* 1612; *Decision of the COP in Its Eighth Meeting, Held in Valencia from 18–26 November 2002 — Principles and Guidelines for Wetland Restoration*, Resolution VIII.16 (26 November 2002) ('Resolution VIII.16').

require support in resolving trade-offs and selecting between allowing an ecosystem to gradually (or rapidly) transform, actively intervening to maintain historically-referenced ecosystem services or, in some cases, facilitating a transition to a more- rather than less-desirable ecosystem state.¹⁶⁴

Legal frameworks will also need to embed, and resource, adaptive management approaches, maximising opportunities to learn from both ‘success’ and ‘failure’ in restoring wetland ecosystem services. Restoration projects ‘break new ground in the understanding of ecosystem processes’ and are almost always experimental in nature.¹⁶⁵ As such, revising project goals, performance standards and remedial actions should be considered a necessary part of every restoration project.¹⁶⁶ New information from strategic and long-term water quality monitoring, revised climate projections and fire events in the landscape must be consistently integrated into cyclical decision-making processes.¹⁶⁷ Adaptive management is often poorly implemented through legal instruments,¹⁶⁸ with impediments including a lack of agency commitment, prohibitive costs, and limitations on learning in highly complex management contexts, where climate and fire regimes interact in sudden and irreversible ways on multiple components of biodiversity.¹⁶⁹ Tools for supporting learning in this environment already exist, and include mandating and enforcing regular review periods for management plans and actions, sunset clauses for regulations and recovery plans, and obligations — on both public and private wetland managers — to report restoration outcomes to publicly accessible databases.¹⁷⁰

VI CONCLUSION

The increasing occurrence of fire in areas that are traditionally not fire-prone creates new challenges for both conservation and wildfire governance. Changing fire regimes create the need for new trade-offs and more effective guidance in contexts of transformation. Choosing whether, when and how to restore

¹⁶⁴ Colloff et al (n 149) especially Table 1.

¹⁶⁵ Resolution VIII.16 (n 163) [32].

¹⁶⁶ Ibid.

¹⁶⁷ Ibid; McInerney et al (n 59).

¹⁶⁸ Jan McDonald and Megan C Styles, ‘Legal Strategies for Adaptive Management under Climate Change’ (2014) 26(1) *Journal of Environmental Law* 25.

¹⁶⁹ Don A Driscoll et al, ‘Fire Management for Biodiversity Conservation: Key Research Questions and Our Capacity to Answer Them’ (2010) 143(9) *Biological Conservation* 1928.

¹⁷⁰ See, eg, Daniel A DeCaro, ‘Legal and Institutional Foundations of Adaptive Environmental Governance’ (2017) 22(1) *Ecology and Society* 32; Annette Stewart et al, *Open Standards for the Practice of Conservation* (nd) <<https://cmp-openstandards.org/cs-examples/case-studies/>>; Ramsar Secretariat, *Case Studies* <http://ramsar.org/strp_rest_index.htm>.

ecosystem services that have been lost in wildfires will also require new legal and technical approaches, from more active engagement with novel assemblages to new forms of procedural and accountability tools.

The Macquarie Marshes is a wetland that has already lost some of the ecosystem services that it historically provided, and it is under increasing threat from changing fire regimes.¹⁷¹ Heavy rainfall and mild summers may help to revive some of the affected reed beds and support the recovery of the marshes in the short term, but climate projections for the region indicate ongoing warming and drying trends, with more frequent, severe fire weather. These projections are replicated across south east Australia, which serves to emphasise the importance of this snapshot of the impact of fire on the Macquarie Marshes — and its increasingly threatened ecosystem services — and the broader significance of the questions it raises for conservation laws that focus on preservation, maintenance and stability.

This article does not suggest that we ‘give up’ on the marshes just yet, nor on other vulnerable wetland ecosystems across the continent. Rather, it proposes that we sharpen our attention on the rapid ecological and climatic changes affecting vulnerable and sensitive wetland ecosystem services. This article demonstrates that, while we must increase our commitment to reducing existing pressures on these systems, particularly in the short term, we must also begin a conversation about what to do when wetland ecosystems are irreversibly transformed so that decision-makers are equipped to respond to the very substantial ecological losses projected as a result of climate change.

¹⁷¹ NSW OEH (n 62).