Reframing ‘environmental net gain’ for the Yarra Birrarung

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Report prepared for the Birrarung Council

Contents

Abbreviations

BSUD	Biodiversity sensitive urban design’
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
DELWP	Department of Environment, Land, Water and Planning
EVC	Ecological Vegetation Classes
NGO	Non-Government Organisation
NRM	Natural resource management
BBOP	Business and Biodiversity Offsets Programme
RPE	Responsible Public Entity
SEPP	State Environment Protection Policy
WSUD	Water-sensitive urban design
YSP	Yarra Strategic Plan

Executive Summary

This report explores the concept of 'net gain for the environment', (referred to as environmental 'net gain' or simply 'net gain'), as it represents a principle of conservation policy and informs policy design.

The term environmental 'net gain' arises from the *Yarra River Protection (wilip-gin Birrarung murron) Act 2017* (Vic), as part of one of a set of 'Yarra protection principle' contained in that legislation . The scheme of the Yarra Birrarung Act is crucial to an understanding of the term: the Act provides the statutory context in which it arises, and the Act establishes the practical (geographical) and policy setting for use and operation of the term.

The Yarra Birrarung Act also establishes a legal framework for future management of a key section of the Yarra landscape (the River corridor). This future management regime is based on an elaborate governance architecture, with a focus on strategic planning and two powerful, guiding devices: a relatively detailed long-term vision (to be developed by the community)and legislative recognition of the fact of the river as a 'living entity', under inspiration from Wurundjeri Woi-wurrung Traditional Owners. In this report, we take the latter to be a reflection of a 'bicultural' model of the river landscape – or in other words recognition of the cultural landscape.

The task of articulating what is meant by 'net gain', so that it can inform policy design, requires consideration of the range of current approaches which can be used to framing the concept. In this report we propose that there are, properly, three approaches which measure net gain in different ways and are based on:

- quantitative measures of 'gain', which reflect of scientific and technical input and 'values' generated by that input
- qualitative measures of 'gain', strongly influenced by models of ecological restoration and schema for recovery of ecological systems
- Cultural measures of 'gain', which sees a cultural as well as physical landscape, and seeks improvement that includes 'healing' and proper 'care' of Country.

This report proposes a 'bringing together' of these various approaches and their related measures of 'net gain' to apply to Birrarung protection . It contends that this is the best way to deliver on the goals of the legislation , and the Community and Traditional Owner aspirations which accompany it. We do not conclude a preferred policy approach or mechanism at an operational level.

The possibility of designing an offsetting or compensatory scheme based on the above matrix of 'measures' is considered briefly. At greater length, this report considers the application of science, the ecosystem restoration model, and the fact of the cultural landscape as it relates to the question of how we frame and apply net gain to the River.

This report includes a review of literature underpinning discussions of the framing of environmental net gain. The relevant sources of literature are vast and so summaries of key features are included. In addition, the report includes certain appended information relevant to the net gain discussion, such as the scope of laws of general application, concerning land and natural resources, applying to the Yarra corridor, and offset policies presently applying in the corridor.

Introduction

The *Yarra River Protection (wilip-gin Birrarung murron) Act 2017* establishes a unique and powerful new approach to managing this river landscape. This fact means that the opportunity exists to take a different approach to the concept of 'net gain for the environment' as it applies to this landscape.

The Act sets out the bicultural character of the 'living' river and has delivered the Long-term Community Vision. We know what the River is and, through the Community Vision, we know where we want the River to be.

In this report, we conclude that the most effective way to achieve the Community Vision for the River is through an approach that gives regard to ecological restoration. There is a well-developed science and method in restoration ecology. It allies with other concepts and approaches, including that of the cultural landscape (healthy Country), and other scientific disciplines. We identify various lenses or perspectives ('frames') through which the question of measurable improvement to the environment and landscape can be considered. We tie these perspectives to the concept of environmental 'net gain'.

'Net gain' has conventionally been understood as 'anchored' in the present state of the environment, with emphasis on detailing current environmental baselines and reacting to assaults on environmental condition. In law and policy, those assaults we refer to as 'impacts'. Under this usage, the 'net gain' calculation responds to instances of harm, loss or damage occurring through development, resource extraction or changed land uses. 'Net gain' is largely a proposition of compensation enabled by fungible, or interchangeable, environmental 'values'. Environmental 'offsets' are the most well-known device enabling 'net gain' calculations in this way. Being so attached to environmental loss or harm, 'net gain', in the company of offsets perhaps, is like a perpetual mourner, unlikely to get beyond grief. Devices such as environmental 'offsetting' may have a role to play in achieving 'net gain for the environment' but they are one feature in a larger story or recovery and restoration.

The Yarra Birrarung Act provides an opportunity to reframe 'net gain' so that the concept, implemented in a bicultural context, is grounded in a community vision for the *future* health of the river.

'Net gain' in this context is best understood as part of pathway, or a stepping stone, to a distinctive and healthier state for the river and its landscape.

'Net gain for the environment' means a strong focus on where the river and its communities are going, measured against where we are now and where we want to be in future. Using the Community Vision and the concept of the 'living' river, 'net gain' can be applied to create the imperative for a the healthier river we aspire to achieve.

Structure of this report

This report is organised into two main parts:

- The first part is the substantive report on framing the concept of 'net gain for the environment' in the context of the Yarra Birrarung legislation.

- The second part of the report comprises an outline of literature and the main themes derived from that literature, which inform the substantive report.

The substantive report (Part 1) includes the following sections:

- Overview of the specific law applying to the Yarra Birrarung corridor, both Aboriginal 'first law' and Parliamentary statute
- Discussion of the various approaches to 'reframing' the concept of 'net gain'
- Discussion how those various 'frames', or lenses, may be brought together strategically.

The review and analysis in this report leads to a loose set of policy principles. The report does not attempt to provide a a concluded view on a policy position as to how the environmental 'net gain' concept might applied.

The analysis does provide a concluded view that environmental 'net gain', as a concept inferring forward-looking improvement, is refracted through various theoretical lenses, the foremost being restoration.

In addition to the two principal parts, appendices are included with the report which outline certain ancillary matters used to inform the report and its main propositions and findings. These appendices concern environmental and natural resources statutes relevant to the Yarra Birrarung corridor, key offsetting schemes applicable in the corridor, and diagrams concerning ecological recovery models derived from restoration standards referred to in this report.
Two case studies are included in this report. One relates to 'net gain' in the context of current biodiversity strategy in Victoria. The other refers to the term in proposed UK environmental legislation.

The Birrarung (Yarra River)

The Yarra River system is an extensive temperate stream system rising in the Great Dividing Range to the east and northeast of Melbourne. The main Yarra Channel ('Yarra Birrarung') flows in excess of 200 km from forested lands in the closed water supply catchment through rural and cleared landscapes to suburban and urban Melbourne. It is the single largest waterway system in Melbourne.
The city was constructed on an extensive delta, with elaborate riverine system to the east and basaltic and plains waterways to the west. Melbourne is situated naturally on a 'meeting point' of natural systems and this is reflected also in the high degree of diversity of ecological systems represented in this region. Urban and peri-urban Melbourne has expanded out across these landscapes.

The Yarra system has been highly modified, and is largely a story of the loss or impairment of ecological function. The Yarra delta for example is now largely lost, except for the river channel itself and small modified wetlands such as Albert Park. Not only does the urban space sit over the top of catchments and floodplains, but additionally the course and flow of these natural features have been extensively re-directed and drained (including underground) and flow regimes attenuated by water supply operations. In southern Victoria the Yarra system is characterised by the highest degree of take or diversion (at around 50% of natural flows).

Part 1. 'River law': law and policy of the Yarra Birrarung

1.1 Wurundjeri Woi wuring lore: the first law of the Birrarung

The following statement introduces the Wurundjeri document *Nhanbu narrun ba ngargunin twarn Birrarung – Ancient Spirit and Lore of the Yarra*:[1]

> The Birrarung is a river of mists and shadows – the river and its environs are a living, breathing entity that follows Wurundjeri Woi wurrung songlines and forms a central part of the Dreaming of the Wurundjeri. A Dreaming that links the billabongs, wetlands and swamps in the upstream forests, across the meandering plains and out to the saltwater. We the Wurundjeri are connected to the Birrarung through spirit, culture and nature. The river follows the paths that our ancestors have travelled for thousands of years - providing for them as now it provides for all Victorians.

The Wurundjeri's relationship with the land extends back tens of thousands of years to when their creator spirit 'Bunjil' formed their people, the land and all living things.

Country and culture are sources of knowledge and lore, which have legal, political and moral force.[2] This inscription of the cultural landscape[3] is common to Aboriginal culture and exercise of sovereignty across the continent. In this report, Wurundjeri cultural knowledge and lore concerning the Birrarung is termed 'first law'.[4]

The Birrarung is a central part of Wurundjeri Country.[5] Wurundjeri are holders and custodians of cultural knowledge of the Birrarung. The pluralistic approach[6] to the Birrarung is expressed in the Wurundjeri water policy document:

> The Wurundjeri believe that we need to change how all Victorians think about and actively respect the Birrarung. We believe we need to see not a resource to be exploited but rather to recognise the complex, living system that is sensitive to its surrounds and a uniquely Victorian treasure. By engaging with those partners with whom we now share the river we, together, are capable of turning around the damage of the past and acting to restore the river and its environment for the future use and enjoyment of all.
>
> Wurundjeri invites all people to see the Birrarung through our eyes, to talk with us to understand our values, and to partner with us to re-energise the river as we fulfil our cultural duty in bringing the Birrarung back to environmental, cultural, ceremonial and spiritual health.

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[1] Wurundjeri Woiwurrung Cultural Heritage Aboriginal Corporation *Nhanbu narrun ba ngargunin twarn Birrarung – Ancient Spirit and Lore of the Yarra* (2019), 5 ('Wurundjeri Water Policy')
[2] Woodward et al (eds) *Our Knowledge, Our Way in Caring for Country: Indigenous-led Approaches to Strengthening and Sharing Our Knowledge for Land and Sea Management* (NAILSMA, CSIRO, 2020), 7 ('Our Knowledge, Our Way')
[3] Bulleen-Banyule CVS, 214: 'Through this approach, the landscape of the Bulleen-Banyule Flats can be understood as being physically and conceptually shaped and constructed through Wurundjeri Woiwurrung occupation, land management, social structures and belief systems. Thus, it may not be viewed as a natural landscape, but a cultural landscape, where the significance is held within the investment of meaning by the Wurundjeri Woiwurrung people.'
[4] Compare Poelina et al 'Recognising the Marttuwarra's First Law Right to Life as an Ancestral Being' (2020) *Transnational Environmental Law* 1, doi:10.1017/S20471025200000163
[5] This particular role and significance of the Birrarung as part of the customary Wurundjeri estate is dealt with at length by the Bulleen-Banyule CVS including with reference to supporting studies. See eg Travers and Martin *Yarra River (Birrarung) Precinct Structure Plan: Cultural Heritage Investigation – Draft Report for DELWP* (GM Heritage and Extent Heritage, 2018), cited in *Cultural Values Study*, 68-69.
[6] See also 'Review of Literature 3: 'Indigenous science' and cultural knowledge' below

This Country is inscribed with cultural heritage places that are a record of Country and the activities of Wurundjeri ancestors. Cultural sites and places in traditional Wurundjeri Country constitute a direct link between contemporary Wurundjeri people and their ancestors who created and cared for those places over millennia.[7]

Wurundjeri cultural practises connect Wurundjeri people to their family, Country, and identity and are tied to Aboriginal tradition. Aboriginal tradition and law is not static and unchanging from a distant 'authentic' past. Aboriginal tradition is grounded in the handing down of beliefs and practices from one generation to the next and it is therefore subject to change over time. Wurundjeri cultural practises include, but are not limited to, activities such as smoking ceremonies and Welcomes to Country (Tanderrum), dance, artwork, traditional music (yidiki), craft, tool production, and custodianship of Country. [8]

Wurundjeri law, consistent with Aboriginal cosmology and practice more generally, is based on landscapes deeply embedded with ancestral connections, humanised and with supernatural characteristics, and relationships of authority and knowledge. The cultural landscape is a living landscape. It includes key creation stories and key (totemic) entities such as Bunjil (eagle) and Waa (Crow).[9] Wurundjeri practical knowledge and use of the landscape retains specific currency for landscape management. It includes matter such as:[10]

- Wio wurrung seasons
- Fire management and fire regimes
- Landscape form and features (in the Heidelberg area)
- Eel fishing
- Material resource use and skilled crafts
- Knowledge of Indigenous plant and animal species including use, significance and names.

As noted below, culture and practise is clearly connected to access to and authority in relation to Country.

The existence of the Birrarung as a cultural landscape is an inherent characteristic of this landscape, given agency through Wurundjeri's ongoing connection, notwithstanding the impact of colonisation on that connection. The fact of the Birrarung as a cultural landscape can be understood in its latency, as well as in revival of culture. An example of this dynamic is included in a recorded statement from a Wurundjeri Elder in the Bulleen-Banyule CVS:[11]

> We never left Country. We were on Country a lot as little fella's, when our families wanted to go for a holiday or camp we all came together and camped on the Yarra Flats [Healesville c1940s- 1960s]. We used to camp up at the bush. We used to fish on the riverbanks and go swimming. Us kids never used to be frightened of jumping in the Yarra. We would swing out into the river off a rope! When the floods were in the big trees used to fall into the Yarra. The big limbs would be laying out, we would walk right out onto the Yarra on them and sit there in the sun. We were bush kids, always around the Yarra. The water starts from the Great Divide and flows all the way down to Heidelberg. It is the same river.

[7] Freedman *Bulleen-Banyule Flats Cultural Values Study* (Wurundjeri Woiwurrung Cultural Heritage Aboriginal Corporation, 2020) ('Bulleen-Banyule Flats CVS')
[8] Wurundjeri Water Policy, 8
[9] Bulleen-Banyule CVS
[10] Bulleen-Banyule CVS; Wurundjeri Narrap team (pers comm, Workshop, 2 October 2020)
[11] Bulleen-Banyule CVS, 234

Cultural values are the responsibility of each person to care for Country. In our traditional culture there were protocols to ensure that the resources we took from Country were not depleted. This includes the responsibility of non-Indigenous people to learn about what Country needs and advocate in the community for healthy Country. We can achieve this together through cross-cultural respect. Viewing the Yarra as a living entity will influence the community to think strategically about how it can be protected into the future. This has always been our cultural attitude to land management.

To us, the cultural values are our Aboriginal values. The Narrap Team participate in water quality testing at Bolin Bolin, Banyule and Willsmere billabongs with Melbourne Water and the Victorian Environmental Water Holder. This testing helps us understand water quality prior to, and after, rewatering events. Audio monitoring at Willsmere Billabong has identified the rare Victorian Smooth Froglet which breeds in autumn when Country is dry. By participating in water quality testing, we learn about what water regimes different species need to thrive and what species need to be reintroduced back into these billabongs.

With our waking up of culture, we are re-establishing traditional connections. It is still ceremony, performed in today's world. The Djirri Djirri Dance Group acknowledges the six layers of Country from Tharangalk, Bunjil's Country, to the water, trees and earth. We have a creation dance about the water catchments flowing into and joining the Birrarung and then out to Port Phillip Bay. These dances are renewing traditional practises. They are relevant because we are here, we are living breathing descendants of the old people. Our dances and ceremonies are created by Wurundjeri women and we follow certain rules. We hold the Wominjeka Bubup Biik-dui (welcome baby to Country) and Murrum Turrukuruk Ceremony (women's coming of age ceremony). When children start dancing, they receive their emu feather skirt. At Murrum Turrukuruk they receive their possum pelt skirt. We hold the ceremonies on Bunjil's Country at Coranderrk in language. If you break the rules when you are representing Djirri Djirri, you have your possum skirt withheld. The reeds for the necklaces that we wear when dancing are collected when they are dry in late November and cut for the necklaces. Cultural revival brings us together.

1.2 The Yarra River Action Plan and *Yarra River Protection (wilip-gin Birrarung murron) Act 2017*

The *Yarra River Protection (Wilip-gin Birrarung murron) Act 2017* (the 'Yarra Birrarung Act') was passed by the Victoria Parliament in September 2017 and commenced on 1 December 2017. This passage followed the now famous address on the floor of the Legislative Assembly by Wurundjeri Elders in English and in Woiwurrung prior to the Minister's Second Reading Speech. The Yarra Birrarung Act represents the first time a Victorian law included Aboriginal language and a bi-cultural approach Victorian law.
The Yarra Birrarung Act was the culmination of a process of policy development and law-making commencing in 2014. The Yarra Riverkeeper Association had advocated for a Yarra River Act and a Yarra Trust. This proposal was reflected in commitments by the incoming ALP Government in late 2014. A wider community campaign commenced in 2015 and in 2016 the Victoria Government established a Ministerial Advisory Committee (MAC) to inquire into and make recommendations on future governance of the Yarra River. The Yarra MAC reported to the Government in late 2016 and in March 2017 the Government published its Yarra River Action Plan, which formed the main policy basis of the subsequent legislative scheme.

Yarra River legislation and integrated planning was the centrepiece of the Yarra River Action Plan. Under the Action Plan the policy framework is guided by overarching objectives for: a healthy river, Great Yarra Parklands, a culturally diverse riverscape, protecting the Yarra corridor, and governance reform.

The historical context for the Action Plan was that river governance faced a third wave of population growth and urban development – the first being the mid-19th century and the second the post-war boom. The third wave requires an effective response, including through managing the important public values of the river corridor.[12] Management of the Yarra River has been the subject of many reviews and reports.[13]

The legislative scheme of theYarra Birrarung Act iis consistent with a significant part of the Yarra MAC 'action plan'. In general terms, the Act:

- Provides for recognition of the Yarra River and declared public lands in its vicinity as part of 'one living and integrated natural entity'14
- Recognises the importance to Melbourne of the ecological health of the river and its landscape, and its environmental significance as a biodiversity corridor
- Enables declaration of the Yarra River and adjacent public lands as 'Yarra River land'
- Sets out mandatory arrangements for integrated strategic planning for the Yarra River corridor, the corridor being a 'Yarra Strategic Plan Area' traversing public and private land within one kilometre of a bank of the Yarra River
- Requires the development of a Long-term Community Vision, to guide the Yarra Strategic Plan and its Land Use Framework, and set out the 50 year ambition for the river corridor. The Community Vision provides a form of reference point for river management and performance into the future. The Yarra Strategic Plan includes a Land Use Framework Plan.
- Sets out a series of 'Yarra protection principles' as guidance on management and governance of the Yarra River corridor
- Establishes mandatory obligations on a series of public authorities15 (and one private entity, the Wurundjeri Tribe Land and Compensation Cultural Heritage Council) to consider and/or act in accordance with 'protection principles' and the strategic planning framework in exercise of their functions and powers as they relate to Yarra River land
- Establishes a new statutory authority, the Birrarung Council, with advisory and advocacy functions in relation to the river
- Establishes the power to declare a Greater Yarra Urban Parklands as a singular entity comprising public open space or parklands.

The Yarra Birrarung legislation is the subject of a growing commentary.[16]

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[12] Victorian Government *Yarra River Action Plan* (2017), 1-2

[13] EJA and YRKA *Charting the Yarra: A Review of 40 Years of Reports and Plans for the Yarra River Corridor* (2015), https://actfortheyarra.org.au/2015/11/11/charting-the-yarra/

[14] *Yarra River Protection (wilip-gin Birrarung murron) Act 2017* (Vic), s 1(a). Subs 5(b) include the object of recognition of 'Crown land and freehold land owned by the State, that is adjacent to the Yarra River and which is used as public open space or as park, [as] part of the one living and integrated natural entity'. The scope of 'recognition' under these purposive provisions varies insofar as the latter object is more confined and implies the relevant public lands are a component ('part') of the wider 'living entity'.

[15] These obligations are implemented through consequential amendments to legislation governing the functioning and powers of the respective public authorities.

[16] Katie O'Bryan 'New law finally gives voice to the Yarra River's traditional owners' *The Conversation*, 25 September 2017, https://theconversation.com/new-law-finally-gives-voice-to-the-yarra-rivers-traditional-owners-83307; Katie O'Bryan 'The changing face of river management in Victoria: the Yarra River Protection (wilip-gin Birrarung murron) Act 2017' (2019) 44 *Water International* 6-7 769; Bruce Lindsay 'Higher and distinctive standards for urban river protection? Special purpose "river laws" and land-use planning' (2020) 37

The preparation of a long-term 'Vision' for the Yarra Birrarung is a key device. The Community Vision provides a general description of the desired future outcome for the river in environmental, social, and cultural terms. The Community Vision traverses the river corridor as a whole and as four specific, regional 'reaches'. The overarching Vision states:

> Our Yarra River, Birrarung, is recognised around the world as an iconic example of a nurturing relationship between a river and its community. Flowing from source to sea, it is the resilient lifeblood of past, present and future generations of Victorians. It connects and enriches our flourishing city, suburbs, regions and beyond. Our Yarra River, Birrarung, its essential role in our lives and its rich history, are respected, understood and protected. It has cared for us for thousands of years and will for thousands to come. The vital and continued role of Traditional Owners as custodians of the River, and its role in their culture, is recognised and celebrated. Our Yarra River, Birrarung and its diverse surrounding landscapes provide a place of refuge, recreation, learning and livelihood. It brings communities together and supports sustainable local economies. Its clean waters and connected network of thriving green spaces nurture biodiversity, and deepen the relationship between people and nature. Our Yarra River, Birrarung is respected as a sacred natural living entity and everyone takes responsibility for its care. Its health and integrity are paramount and uncompromised. What is good for the Yarra is good for all.

The Community Vision is linked with the Wurundjeri perspective.[17] The Community Vision is the driver of the strategic planning scheme for the river corridor.[18]

Uniquely, the legislation contains a Preamble drafted in both English and Woi wurrung, the language of Wurundjeri. A legislative preamble is relevant to the interpretation and meaning of a statute. The Preamble recites:

- The importance of the Yarra River to Melbourne.
- The intention of the Parliament to keep the river 'alive and healthy for the benefit of future generations'.
- Recognition of the 'intrinsic connection' of traditional owners to the river and 'its Country' and recognises them as 'custodians' of the 'land and waterway they call Birrarung'.
- In English and Woi wurrung, the meaning of Birrarung and the Woi wurrung connection to it.

The statutory scheme of recognition, protection and management of the river and its landscape is informed by what we refer to as a 'bi-cultural' character. This is a common and integrated 'settler' and Aboriginal (Wurundjeri Woi-wurrung) understanding. This character is evidenced in the Preamble and the 'living entity' concept. The latter is informed by Wurundjeri Woi wurrung knowledge and value systems, specifically the fact of the river as Birrarung. In addition, the bi-cultural character of the river is informed by the intention for Wurundjeri to have a distinctive, participatory role in governance.[19]

Environmental and Planning Law Journal 3 322; Rebecca Nelson 'Sick city streams: new approaches to legal treatments' (2020) 43 *Melbourne University Law Review* 2 748

[17] See for example textual reference to Wurundjeri role and perspectives in river governance in Melbourne Water *Yarra River 50-Year Community Vision* (2018), 4,9, and prominence of Wurundjeri input into the *Draft Yarra Strategic Plan* (2020), 19-25.

[18] The Yarra Strategic Plan is required to 'give effect to' the Community Vision: Yarra River Protection (wilip-gin Birrarung murron) Act 2017 (Vic), subs 20(1)(a)

[19] At least two members out of 12 on the Birrarung Council are set aside for nominees of the Wurundjeri council: *Yarra River Protection (wilip-gin Birrarung murron) Act 2017* (Vic), subs 49(1)(a). Cultural principles under the Act emphasise Aboriginal (Wurundjeri) involvement in decision-making: *Yarra River Protection*

1.3 'Net gain' within the Yarra Birrarung Act

The term 'net gain' is contained in the Yarra protection principles but is not defined in the legislation. The term is open to interpretation but can be understood as referring to measurable improvement in environmental condition, health or integrity. Environmental 'net gain' infers a trajectory (or trajectories) of improvement in environmental condition for the Yarra Birrarung corridor.

All of this begs questions as to how we construct the appropriate 'measure', how we settle on 'improvement', and how we understand the relevant 'environment' and its condition? All of these factors are integral to the issue of 'framing'.

We will come to these questions. First let us consider the statutory context of 'net gain'.

Sixteen (16) Yarra protection principles in the legislation are set out under six categories: general, environmental, social, recreational, cultural and management principles. The operation of the principles is enlivened through two mechanisms:

- The requirement that the Yarra Strategic Plan must be prepared with regard to the Yarra protection principles
- The requirements that each Responsible Public Entity must have regard to the principles when performing a statutory function or duty or exercising a statutory power in relation to the Yarra Strategic Plan Area that may affect Yarra River land.

The second obligation does not apply to a function or power relating to a declared project under the *Major Projects Facilitation Act 2009*.

The Yarra Birrarung Act provides no guidance on weight or priority to be given to any particular protection principle, or class of protection principles, in relation to preparation of the Yarra Strategic Plan or the exercise of statutory functions, duties or powers. Weight or relevance would be a matter of agency judgment in any particular circumstances. However, the ordinary rules of statute construction will apply. Those rules include that the Act must be interpreted so as to give effect to its purposes and objects. A key theme in those purposes and objects is ensuring 'health' of the 'living' river.

Section 8 includes a principle of integrated decision-making requiring environment, social and cultural considerations in actions and decision-making.

Section 9 of the Act sets out 'environmental principles' and it is here that the term net gain is used:

> There should be a net gain for the environment in the area of Yarra River land arising out of any individual action or policy that has an environmental impact on Yarra River land.

(wilip-gin Birrarung murron) Act 2017 (Vic), subs 12(1)-(2). In practice, Wurundjeri have taken a leading role in setting out themes, directions and ambitions of planning, such as in drafting content for the Yarra Strategic Plan, advocating stand-alone water policy, and informing content and preparation of the Long-term Community Vision.

Section 12 sets out cultural principles and the role of Aboriginal Traditional Owners in governance and management.

Under subsection 9(4), environmental 'net gain' should be applied to any specific 'action or policy' that has an environmental impact on Yarra River land. The concept of net gain is therefore relevant to the preparation of a Yarra Strategic Plan and to the conduct of public agencies under the Act.

This sub-section of the Act is somewhat unique in foreshadowing application to 'any *individual* policy or action' (emphasis added). It appears intended to be applied with a certain degree of precision.

This subsection also contains important qualifications to the framing of the 'net gain' concept.

Firstly, 'net gain' is to be 'net gain *for the environment'*. 'Environment' refers broadly to the biophysical environment plus aesthetic considerations.[20] How these factors are *known* may traverse knowledge systems. The Act suggests this is an intended approach. It is conventional that science informs environmental considerations. At the same time, section 12(1) provides for Aboriginal cultural knowledge (alongside values and heritage) as a basis for action on matters to which the Act relates. It is therefore open for Wurundjeri Woi wurrung knowledge of natural, biophysical or aesthetic features of Yarra River land to be 'reflected' in the understanding of 'environment' on which the Act relies. It is arguable there is a further imperative for that knowledge to be 'acknowledged… protected and promoted.' There is nothing in this approach that constrains knowledge to a point in time (for example, pre-European) or insists that Aboriginal knowledge (or values or heritage) is not evolving, re-emerging or being revitalised, for example via recovery of Woi-wurrung language.

Secondly, section 9(4) requires 'net gain for the environment' to have some nexus to 'Yarra River land'. This would appear to include beneficial outcome ('net gain') directed to Yarra River land ('in the area of Yarra River land'). An environmental impact triggering a 'net gain' response potentially could be a direct impact on Yarra River land or an indirect impact on Yarra River: an impact elsewhere that has a consequential effect on Yarra River land. Judicial and legislative approaches to 'impacts' under environmental law elsewhere would suggest this broad approach is appropriate.[21]

1.4 The policy approach flowing from the Yarra Birrarung Act: vision, the 'living river', and performance

The Yarra Birrarung Act establishes arrangements for river corridor management and for assessing how well this management is performed. The statutory framework focuses on the system of corridor-wide strategic planning implemented under the auspices of public

[20] *Yarra River Protection (wilip-gin Birrarung murron) Act 2017* (Vic), s 3 ('environment'). This definition has its origins in environmental protection law: see *Environment Protection Act 1970* (Vic), s 4 ('environment')
[21] *Minister for Environment and Heritage v Queensland Conservation Council Inc* [2004] FCAFC 190 ('Nathan Dam Case'); *Environment Protection and Biodiversity Conservation Act 1999* (Cth), s 527E. See commentary at 'Nathan Dam Case', http://envlaw.com.au/nathan-dam-case/

agencies, with the intention of achieving the high-level Community Vision outcome[22] and a 'healthy, 'living' river. The strategic planning scheme must include both 'broad objectives' for a range of matters and 'performance objectives'. The strategic planning scheme represents a form of 'stepping stone' approach, implemented over time, in order to achieve the Community Vision and 'living' river outcome.[23] Four high-level performance objectives have been proposed under the Draft Yarra Strategic Plan:

- a healthy river
- a culturally diverse river corridor
- quality parklands for a growing population and
- protecting the natural beauty of the Yarra River corridor.[24]

The statutory scheme and policy emphasis in the Yarra Birrarung Act is *directed to future outcomes and demonstrable progress toward them.* Ambitions and envisaged outcomes and guide performance. Starting points or baselines are important but not conclusive. They are enabling. They are not as critical as the future state, or outcomes, achieved. How outcomes are to be achieved and measured is of paramount importance.

New governance arrangements are enacted required to implement and oversee the performance-based model. These include the various public agencies ('Responsible Public Entities', which include the Wurundjeri) responsible for implementation, the Lead Agency responsible for planning, the Birrarung Council responsible for oversight, advice to government on YSP implementation and advocacy, and the Commissioner for Environmental Sustainability who is responsible for reporting on environmental performance.

Reporting on the environmental condition of Yarra River land is carried out through five yearly environmental reporting by the Commissioner for Environmental Sustainability.[25] An initial report prepared in 2018,[26] forms a type of 'baseline' assessment of the 'environmental condition' of the Yarra Birrarung. The reporting framework[27] includes qualitative and quantifiable indicators of environmental performance, adapted from UN Sustainable Development Goals.[28] The reporting framework used owes its inspiration to models of 'natural capital' accounting and environmental economics.

[22] 'The Yarra Strategic Plan must… give effect to the vision expressed in the long-term community vision document…' *Yarra River Protection (wilip-gin Birrarung murron) Act 2017* (Vic), subs 20(1)(a)
[23] In effect, there are to be a series of at least four Yarra Strategic Plans designing and implementing actions and policies giving effect to the Community Vision: a new Yarra Strategic Plan must be prepared no later than 10 years after an existing Plan has commenced: *Yarra River Protection (wilip-gin Birrarung murron) Act 2017* (Vic), s 42.
[24] Melbourne Water *Draft Yarra Strategic Plan* (2019), 13, 30-39
[25] *Commissioner for Environmental Sustainability Act 2003* (Vic), s 17A
[26] Commissioner for Environmental Sustainability *State of the Yarra and its Parklands Report* (2018)
[27] Commissioner for Environmental Sustainability *Framework for the Victoria State of the Environment report 2023: Science for Sustainability Development* (2018), https://www.ces.vic.gov.au/sites/default/files/CESV_Framework%20Report%202023_FINAL_WEB.pdf
[28] We would argue that the breadth of indicators used under the SDG model is not applicable to performance reporting for the Yarra Birrarung. Specifically, reporting in respect of the Yarra Birrarung is on 'environmental condition'. This can and should be interpreted broadly but 'environment' in this context is not infinitely flexible.

An effective performance model requires a broad set of performance indicators, including cultural indicators reflective of Aboriginal (Wurundjeri Woiwurrung) values. Recent *State of the Environment* reporting has taken this approach.[29]

The model of performance established under the Yarra Birrarung Act requires measurable and demonstrable performance at a strategic and landscape scale. The relevant geographic scale is the declared corridor of the 'Yarra Strategic Plan Area'. This planning area is linked to wider catchment management through design and implementation of the regional waterway strategy ('Healthy Waterways Strategy').

In this regard, 'net gain' is, *inter alia*, a touchstone of ambition, contribution and achievement when considering 'individual actions and policies' affecting the Yarra Birrarung.

Net gain' example 1: Victorian biodiversity policy

Framing 'net gain' for the Yarra Birrarung warrants considering how the concept is understood and used in in current Victorian policy. Trajectories of 'gain' anticipated for the Yarra Birrarung are likely to long outlast present policy settings. Comparison between current policy and the Yarra Birrarung Act 'net gain' concept is instructive.

Environmental 'net gain' informs Victorian biodiversity policy, as expressed in Victoria's Biodiversity Strategy.[30]

Until 2013, a 'net gain' goal informed planning rules governing biodiversity and management of native vegetation. The concept was defined as 'the outcome for native vegetation and habitat where overall gains are greater than overall losses and where individual losses are avoided where possible.'[31] This was to be achieved through quantitative and qualitative measures.[32] Those rules now refer to the aspiration of 'no net loss'.[33] The ambition of using legal controls, through planning, to achieve 'net gain' outcomes has been replaced by the view that regulation is best suited to a neutral ambition and other actions, such as investment and conservation policy, are best suited to achieving improvement in environmental condition.[34]

[29] See Commissioner for Sustainability and the Environment (ACT) *ACT State of the Environment Report* (2019), 46-47, https://envcomm.act.gov.au/soe_about-the-report/. Commissioner for Environmental Sustainability *State of the Yarra and its Parklands Report* (2018), 25, 36-41. The State of the Yarra Report found that cultural landscape health indicators are, for the purposes of reporting, unknown, and recommended development of these indicators, in order to inform future reporting and management, reflecting Wurundjeri values.

[30] Government of Victoria *Protecting Victoria's Environment – Biodiversity 2037* (2017) ('Biodiversity Strategy')

[31] DSE *Victoria's Native Vegetation Management: A Framework for Action* (2002), 18. The specific expression of ecological improvement referred to is 'rehabilitation and revegetation [of native vegetation] with indigenous species for biodiversity conservation and land and water resource outcomes.' Ibid, 18

[32] The two primary forms of measuring change in native vegetation where the habitat hectare assessment method, which is a measure of both area (quantifiable extent) and habitat conditions (qualitative assessment give numerical scoring), combined with the number and characteristics of scattered trees.

[33] See Appendix 2 below

[34] This approach of focusing legal or regulatory effort on control, via prohibitive or directive means, of native vegetation (biodiversity) loss or clearing, rather than positive obligations on regulated actors (such as developers or resource users) to implement 'gain' or conservation outcomes, was expressed early in the consideration of the 2002 Native Vegetation Management Framework by VCAT: see *Villawood Properties Pty Ltd v Greater Bendigo City Council (Red Dot)* [2005] VCAT 2703, [9]-[10]

The ‘net gain’ ambition under the current Biodiversity Strategy is defined in terms of:

- Arresting further decline in the conservation status of species and communities identified as vulnerable or near-threatened;
- Finding reasonable means of intervening to avoid extinction of species and communities at higher risk of extinction; and
- Improving native habitats generally in a targeted fashion across Victoria.

A key measure of ‘net gain’ in this policy context is ‘change in suitable habitat’. This is a technique used in the Strategy to measure the impact of management interventions, based on expert input, assumed to improve habitat conditions.[35] Incremental positive changes over time (50 year time horizon) are intended to enable ‘net gain’. The policy basis of the Strategy prioritises conservation investment, especially interventions focused on ameliorating biological threats to native habitat (such as invasive species) and volunteer conservation effort. Geographic distribution and prioritization of conservation efforts are informed by digital modelling. Targeting of ‘gain’ is thereby guided by outputs from these models, termed ‘strategic management prospects’. The accumulated ‘gain’ derived from these targeted interventions is assumed to provide a ‘net gain’ over time.

‘Net gain’ is associated with a ‘healthy’ natural environment,[36] (an ambition potentially aligning with Yarra Birrarung ambitions). However the Strategy is designed for Victoria as a whole. It prioritises action and cost-effectiveness of investment at that scale. It does not necessarily respond fully to context, priorities, or strategic considerations at the local level. For example, according to investment targeting under its strategic management prioritisation, virtually all investment is upstream of Warrandyte.

The technical foundations of the Biodiversity Strategy are somewhat problematic. In particular, the causal model underpinning the ‘change in suitable habitat’ method of assessing ‘improvement’ and ‘gain’ is relatively deterministic.. It uses a relatively simple (cause-effect) model of causation[37] and does not reflect more complex and generally accepted patterns of ecological system behaviours.. Arguably it fails to have full regard to ecological theory and concepts.

[35] Biodiversity Strategy, Appendix 1; DELWP *Deciding Which Actions Best Help Nature*; DELWP *Biodiversity Knowledge Framework*

[36] Biodiversity Strategy, 14

[37] See DELWP *Knowledge Framework* (2019), 42: ‘…a deeper dive into the ecological and human mechanisms influencing this uncertainty is required to identify knowledge gaps and therefore research questions. This is achieved through the development of causal models that map the causal relationships between ecological and human components relevant to the benefit of an action being realised. This is done using a technique called fuzzy cognitive mapping. Causal models (describing the difference between the best and worst-case causal models) (Figure 1) represent our shared understanding of the management action, and uncertainty in that understanding, and how drivers and threats, and other relevant processes interact to influence the availability of Suitable Habitat for the species. Causal models are graphical representations in which key concepts are nodes and causal relationships are the links between them. The models reflect a narrative of cause and effect, summarising what experts believe to be the key elements of a system, their dependencies and interactions. Positive links indicate a direct relationship between parent and child notes (as the parent increases, so too.’

The theoretical underpinnings of 'net gain' in the Biodiversity Strategy are indeed based on a theory of *change* or *improvement*. However, this approach is more limited and confined than a theory of ecological *restoration* or *recovery* which is discussed later in this report.

There are synergies between what the Biodiversity Strategy is intending to do, including its 'net gain' ambition, and the intended application of the Yarra Birrarung Act. These include high-level goal-setting, systems of measurement and accounting, and improvement in ecological performance over time.

The Biodiversity Strategy provides a stepping off point for a systematic appraisal of environmental 'net gain' and socio-ecological policy.

1.5 Reframing net gain

The brief informing this project seeks options for reframing the net gain concept.

The term net gain implies that environmental improvement will be achieved. The reframing exercise will be guided by three principal constructs for measuring improvement:

- A quantitative measure, influenced by ecological and sustainability sciences and given mathematical or statistical expression
- A qualitative measure, indicative of recovery of ecosystems and grounded in restoration science
- A cultural measure, based on indicia of health and 'healing' of Country and informed by cultural knowledge and Wurundjeri agency.

1.5.1 Science and quantification of 'net gain'

A well-established and conventional approach to conservation policy emphasizes *quantification* of environmental qualities, values and characteristics. This approach focuses on representing natural phenomena or processes in statistical or mathematical form, sometimes referred to as 'metrics'. It is influenced significantly by ecological sciences, but influences on generating ecological 'metrics' have also come from economics, urban planning, and public administration. Interdisciplinary guidance has seen notions of 'sustainability sciences'[38] or 'urban sciences'[39] emerge, bringing together ecological and other knowledge.

Scientific knowledge can help to produce statistical models for understanding natural systems and processes. This work represents an important and powerful tool for ecological management. It can help us recognise behaviours and trends in nature as well as design and target interventions. In this way science based modelling can be crucial in designing of conservation measures for integration into broader planning and management efforts.

[38] Faber et al 'Homo oeconomicus and homo politicus in ecological economics' (2002) 40 *Ecological Economics* 323
[39] Parris 'Do we need a new theory of urban ecology?' (2016) 47 *British Ecological Society Bulletin* 4 28

Various models addressing quantification of environmental 'gain' are relevant to the Yarra Birrarung corridor. Two important schemes are 'gain scoring' under native vegetation guidance and methods for assessing biodiversity values for the purposes of the *Environment Protection and Biodiversity Conservation Act 1999* (Cth) (EPBC Act).[40] Construction of 'gain' under native vegetation policy is an ensemble of delineated values operating as proxies for important ecosystem properties. These include habitat, landscape connectivity, scattered trees, and wetlands. The comparable calculation of 'gain' operating under the EPBC Act relates to 'matters of national environmental significance', including listed threatened species.

Values associated with 'gain' under such models are intended to target selected ecological factors deemed as biophysical priorities, usually because they are proxies (indicators or surrogates) for broader ecosystem function or structure.[41] This suite of values will likely be important ecologically but they do not, and are not intended to, serve as complex and wholistic sets of ecosystem parameters. Values, indicators or surrogates associated with environmental 'gain' reflect strategic choices and underlying assumptions as to the nature of an ecosystem and preferred pathways or interventions for its management. Without a clear sense of the ecosystem in which environmental 'gain' is situated and well-developed management goals and objectives, the values and indicators chosen may not be the optimal or correct ones.[42]

This process of ascribing 'value' to nature is an important part of environmental policy. It relies on a conceptual process of isolating, distinguishing and characterising a natural feature or process. The relationship to other features or processes may be important too. Natural values can be quantified and set out as part of mathematical schema that explain their role or significance. Mediated by science in this way, nature is reflected in 'informational' systems.

Quantifying environmental 'net gain' in scientific terms can result in a multitude of numerical values, 'scores' or 'metrics' intended to reflect environmental condition. These values can include measures of area, habitat quality, species populations and diversity, hydrology, ecological connection, or economic value, alongside many other indicia of nature or of social-ecological systems.

Quantitative and statistical expression of environmental condition is important to environmental assessment and decision-making. For example, statutory decisions concerning development are routinely accompanied by 'decision support tools'[43] aimed at quantifying environmental impacts and countervailing measures.

Three broad areas of environmental thinking, policy and /or practice are strongly influenced by this type of 'framing': environmental offsetting, ecological economics, and urban 'greening' and environmentally 'sensitive' cities.

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[40] See Appendix 2 below

[41] See generally Lindenmayer et al *Indicators and Surrogates of Biodiversity and Environmental Change* (CSIRO Publishing, 2015)

[42] See Lindenmayer et al 'A diversity of approaches to ecological surrogates and key knowledge gaps' in Lindenmayer et al *Indicators and Surrogates of Biodiversity and Environmental Change* (CSIRO Publishing, 2015), 189-194

[43] See eg DEWLP 'Nature Print and Strategic Management Prospects', https://www.environment.vic.gov.au/biodiversity/natureprint

Quantitative 'framing' of environmental values is reflected in a wide range of theories, techniques and models informing environmental management. As we have seen, this approach has also influenced current biodiversity policy where change is measured in terms of 'change in suitable habitat'.

One of the most well-known and influential approaches that focuses on quantification of ecosystem properties and behaviours is the theory of 'natural capital' and/or 'ecosystem services'. 'Natural capital' and 'ecosystem services' concepts are integral to models of environmental accounting and ecosystem assessment.[44] Their influence permeates international-institutional thinking and practice and, in Australia, national[45] and regional science-policy interactions. The latter includes *State of the environment* and *State of the Yarra* reporting. 'Natural capital' models are not without critique.[46]

The essence of 'natural capital' and 'ecosystem services' theory is that nature can be understood as an integral biophysical foundation of human welfare ('well-being'). Nature supplies a range of benefits to human society, according to various classes of contribution, such as 'provisioning' basic physical needs through to 'regulating' ecosystem functioning itself. In this manner, nature can be attributed discrete and disaggregated 'values', which are quantifiable. In principle, ecosystem values are quantifiable in monetised as well as non-monetary terms.

'Natural capital' accounting and use of discrete, quantifiable ecosystem values can be used in restoration schemes and projects. Their use can include complex restoration 'credit' scoring systems.[47]

A broad range of sciences will be essential to construct measures of environmental value, depending on the schema of values intended to inform 'gain' – that is, environmental outcomes sought. For the Yarra Birrarung that overall goal is reflected in the Community Vision and it is intended to be achieved through the strategic planning framework and statutory obligations set out under the Yarra Birrarung Act.

The knowledge base informing quantitative measures of 'gain' can include social and cultural sciences. Metrics and indicia used need not – and arguably, should not – be confined to

[44] See generally UN *System of Environmental Economic Accounting 2012 – Central Framework* (2014), https://seea.un.org/content/seea-central-framework; Millennium Ecosystem Assessment *Ecosystems and Human Well-being: A Framework for Assessment* (2005), https://www.millenniumassessment.org/en/Framework.html; The Economics of Ecosystems and Biodiversity (TEEB) *Mainstreaming the Economics of Nature: A Synthesis of Approach, Conclusions and Recommendations of TEEB* (2012), http://teebweb.org/publications/teeb-for/synthesis/

[45] Eg BoM *Guide to Environmental Accounting in Australia* (2013), http://www.bom.gov.au/environment/doc/environmental_accounting_guide.pdf

[46] See eg Buscher and Fletcher 'Nature is priceless, which is why turning it into "natural capital" is wrong' The Conversation, 22 September 2016, https://theconversation.com/nature-is-priceless-which-is-why-turning-it-into-natural-capital-is-wrong-65189; Monbiot 'Put a price on nature? We must stop this neoliberal road to ruin' The Guardian, 24 July 2014, https://www.theguardian.com/environment/georgemonbiot/2014/jul/24/price-nature-neoliberal-capital-road-ruin

[47] See eg Willamette Partnership *Developing the Willamette Ecosystem Marketplace* (2008), https://willamettepartnership.org/wp-content/uploads/2014/09/Developing-the-Ecosystem-Credit-Accounting-System.pdf

biophysical categories. Arguably, for the Yarra Birrarung, 'gain' in cultural terms may be informed by the growing body of work traversing cultural and scientific knowledge.[48]

Scientific metrics and indicators provide insights into patterns of environmental change, or into the direction (trajectory) of overall environmental or ecosystem condition. This includes whether the state of ecosystem health is improving, stagnating or declining. These indicators can be set out in diagrammatic and mathematical forms, such as occurs in 'state of the environment' reporting.

However metrics does not necessarily provide comprehensive or effective insight into what is underpinning change. Nor does quantification alone tell us what conditions are necessary to enable the change sought, or help choose techniques to implement change ('gain').

In summary, quantitative techniques are important 'tools' for planning and measuring change ('gain'). But these tools have limitations: we need to know *why* we are measuring things in this way and keep a clear line of sight on how measured results link to high level goals
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1.5.2 Restoration and the qualitative measure of environmental 'net gain'

A second broad field of conservation science and practice has emerged in recent decades, with a particular focus on ecosystem change and recovery. This field of praxis (practise informed by theory and vice versa) responds to the need to manage and ameliorate environmental harms and damage, and to set out pathways and mechanisms for repair of damaged ecological systems. This field is associated with restoration ecology science and practice.[49]

While recognising the importance of quantitative approaches to measure environmental changes, restoration science and practice requires that an *ecological trajectory* needs to be planned, to guide efforts towards the restoration goal. Once such a trajectory is planned and understood, progress can be measured systematically. It is not sufficient that a general goal or intention of restoration, improvement or 'gain' is attached to a conservation policy. Specifically, the focus of restoration science is on measuring ecological *recovery*, or trajectories of change in restoration of ecosystems, and understanding it against sought outcomes.

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[48] See eg the synthesis of ecosystem services model and cultural priorities in Bark et al 'Operationalising the ecosystem services approach in water planning: a case of Indigenous cultural values from the Murray-Darling Basin, Australia' (2015) 11 *International Journal of Biodiversity Science, Ecosystem Services and Management* 3 239; Sangha and Russell-Smith 'Towards an indigenous ecosystem services valuation framework: a North Australian example' (2017) 15 *Conservation and Society* 3 255

[49] See generally Falk et al (eds) *Foundations in Restoration Ecology* (Island Press, 2006); Allison and Murphy (eds) *Routledge Handbook of Ecological and Environmental Restoration* (Routledge, 2017), Jones 'Ecosystem restoration: recent advances in theory and practice' (2017) 39 *The Rangeland Journal* 417; Hagen et al *Restoration Priorities and Strategies: Restoration to Protect Biodiversity and Enhance Green Infrastructure – Nordic Examples of Priorities and Needs for Strategic Solutions* (Nordic Council of Ministers, 2016), Campbell et al 'Reflections on four decades of land restoration in Australia' (2017) 39 *The Rangeland Journal* 405; SER *International Principles and Standards for the practice of Ecological Restoration* (2nd ed, 2019); SER Australia *National Standards for the Practice of Ecological Restoration in Australia* (2nd ed, 2018); IUCN Commission on Ecosystem Management 'Restoration', https://www.iucn.org/commissions/commission-ecosystem-management/our-work/cems-thematic-groups/restoration.

We set out the main themes and ideas of ecological restoration literature below, with particular attention to international principles and standards for design and assessment of restoration.

Built into the approach of restoration science is the notion that we need to measure states or conditions of environmental recovery (that is, recovery of natural systems)in order to ensure their integrity and sustainability. This insight is particularly important in assessing environmental 'performance', or the recovery of natural systems under the influence of human interventions, actions and conduct. Recovery states are measurable against outcomes sought.[50] Recovery states sought must be informed by science (and other knowledge bases), and use indicia of recovery such as increasing complexity and self-organising function of ecosystems.[51] The ultimate goal state sought, the reference model, is an actual or inferred state of recovered (restored) ecological function or character. Restoration science sets out key *qualitative* measures of positive ecological change (recovery), under human influence and intervention. Recovery outcomes sought are used to develop standardised frameworks for environmental 'gain' and improvement.

In principle, recovery can apply to entire ecosystems or landscapes, as well as individual threatened species (as threatened species recovery planning would suggest).

A diagrammatic representation of the scheme of recovery set out in international guidance is reproduced in Figure 3.[52]

[50] See SER *International Principles and Standards for the practice of Ecological Restoration* (2nd ed, 2019), Principle 6, 40-45
[51] Ibid
[52] See also Appendix 3 below

NUMBER OF STARS	SUMMARY OF RECOVERY OUTCOME
★	Ongoing deterioration prevented. Substrates remediated (physically and chemically). Some level of native biota present; future recruitment niches not negated by biotic or abiotic characteristics. Future improvements for all attributes planned and future site management secured.
★★	Threats from adjacent areas starting to be managed or mitigated. Site has a small subset of characteristic native species and low threat from undesirable species onsite. Improved connectivity arranged with adjacent property holders.
★★★	Adjacent threats being managed or mitigated and very low threat from undesirable species onsite. A moderate subset of characteristic native species is established and there is some evidence of ecosystem function commencing. Improved connectivity at the landscape scale is in evidence.
★★★★	A substantial subset of characteristic biota present (representing all species groupings), providing evidence of developing community structure and of ecosystem processes. Improved connectivity established and surrounding threats being managed or mitigated.
★★★★★	Establishment of a characteristic assemblage of biota to a point where structural and trophic complexity to a level of very high similarity to the reference ecosystem is likely to develop with minimal further restoration interventions. Appropriate cross-boundary flows are enabled and commencing and resilience is restored with return of appropriate disturbance regimes. Long-term management arrangements in place.

Figure 1: SER '5 star recovery' model

Source: SER *International Principles and Standards for the practice of Ecological Restoration* (2nd ed, 2019)

The concept of ecological restoration is not without its ambiguities and controversy, including that it is revisionist and looks to ideal past natural states. This criticism can be easily dismissed if we posit the term as intentional human activity directed to recovery of ecosystem health, integrity or sustainability.[53] rather than to a re-creation of a past state. This approach focuses on the natural qualities of ecosystems, indicia of integrity or health intrinsic to those systems, and human interventions strategically designed to enable the internal dynamics or momentum of ecologies.[54] The object of restoration is not an idealised past state but a feasible future state of ecosystem health, which may include pre-existing ecologies if they can realistically be achieved. We are concerned with *restoration not reminiscence*, as Ben Richardson reminds us.[55]

These recovery concepts need to include social, institutional and cultural as well as environmental expressions of restoration. The ecological restoration paradigm sees trajectories of recovery occurring in *socio-ecological contexts*. Cultivating the social bases and relationships enabling restoration is integral to success, as is building the institutional tools to do so, such as collaborative planning,[56] financing arrangements and accounting mechanisms, and socio-cultural indicia to measure improvement.

[53] SER International Principles and Standards, 15-17
[54] Akhtar-Khavari and Richardson 'Ecological restoration and Anthropocene' in Akhtar-Kharavi and Richardson (eds) *Ecological Restoration Law: Concepts and Case Studies* (Routledge, 2019), 4-5
[55] Ben Richardson 'Restoring layered geographies: recovering nature's past for the future' (2017) 26 *Griffith Law Review* 2 154
[56] See Carr et al 'Capitalising on conservation knowledge: Using Conservation Action Planning, Healthy Country Planning, and Open Standards in Australia' (2017) 18 *Ecological Restoration and Management* 3 176

The particular value of an ecological restoration approach in the Yarra Birrarung context arises from the clear future orientation of the statutory scheme. This future focus is consistent with an 'anticipatory' ecological restoration.[57] built on moving to an articulated future statewhich looks to a restored future state. The Act and its policy basis require attention to be given to the 'community vision' for the river. This statutory scheme implies there is a trajectory or pathway of change to achieve the vision. While its focus is not confined to the ecological, the scheme of the Act does require that a principal object of these future-directed ambitions are ecological insofar as they are directed to a 'healthy' and 'living' entity. Weight should be given to ecological considerations.

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There are high level, authoritative standards and principles available to guide restoration programs and models.[58] Ecological restoration is a rapidly emerging field of practice There is a proliferation of practical examples, both within Australia and globally. There is also a rapidly growing transdisciplinary literature on ecological restoration (practice) and restoration ecology (theory). In summary, some of the key messages restoration literature tells us:

- Restoration is framed as a form of purposive, structured and organised 'change'. It is, in effect, a project of ordered and principled[59] experimentation.[60]
- Ecological *recovery* can provide a systematic approach to change, improvement and restoration *trajectories*.[61]
- The qualitative standard of recovery, measured against reference models, may be full recovery of an ecosystem[62] or a 'highest attainable level of recovery'.[63]
- Restoration and recovery can occur at highly variable time and spatial scales. Recovery of wetland function might occur in a period of a few years, whereas restoration of forest ecosystems can take centuries. Restoration projects can function at the scale of suburban gardens or continental landscapes. Spatial and temporal scales can be guided by ecologies (such as genetic populations) or institutions (such as land tenure). Restoration strategies may operate at multiple temporal and spatial scales.
- Restoration has objective (natural) and subjective (social) dimensions. The fate of ecologies can be seen in changes and conditions of natural systems, but restoration is a socio-ecological project. It must be measured in terms of the quality, extent and geography of organisation and practice. Organisational of restoration is reflected in

[57] Young Chio 'Considering the future: anticipating the need for ecological restoration' in Stuart Allison and Stephen Murphy (eds) *Routledge Handbook of Ecological and Environmental Restoration* (Routledge, 2017), 7-15

[58] See especially SER *International Principles and Standards for the Practice of Ecological Restoration* (2019), https://www.ser.org/page/SERStandards/International-Standards-for-the-Practice-of-Ecological-Restoration.htm

[59]SER *International Principles and Standards for the Practice of Ecological Restoration;* Higgs et al 'On principles and standards in ecological restoration' (2018) 26 *Restoration Ecology* 3 399

[60] See eg Zedler 'Ecological restoration: guidance from theory' 3 *San Francisco Estuary and Watershed Science* 2, https://escholarship.org/content/qt707064n0/qt707064n0.pdf; Palmer et al 'Ecological theory and restoration ecology' in Falk et al (eds) *Foundations in Restoration Ecology* (Island Press, 2006), https://www.researchgate.net/profile/Donald_Falk/publication/40777417_Foundations_of_Restoration_Ecology/links/00b7d528b8edd4e916000000/Foundations-of-Restoration-Ecology.pdf#page=14

[61] The model of recovery includes removing and ameliorating degrading factors, and effecting positive actions directed to building ecological integrity, such as trophic complexity, connectivity, species diversity and self-organising systems. Halting degradation can include consideration of authorised, permitted and 'grandfathered' human impacts.

[62] SERA National Standards for the Practice of Ecological Restoration in Australia (2018), Principle 4, 13-15

[63] SER *International Principles and Standards for the Practice of Ecological Restoration* (2019), Principle 6, 40-45

the role of state agencies, in community and civil society organisation, in networks and collaborations, ethical mindsets, and appropriate governance systems. Restoration relies on a *social* ecosystem as well as natural environments.

- There are cultural as well as natural indicia of restoration and recovery. Cultural indicia of restoration should reflect the agency of groups and social sectors involved, the 'first law' and the custodial role of Traditional Owners.
- Law and policy need to reconcile with and learn from ecological science and theory. It is well-established that ecosystems are complex and dynamic phenomena, subject (by definition) to system based rather than deterministic properties and behaviours. These properties mean ecosystems are more analogous to organisms or 'entities' than to machines.[64] Few insights of ecological theory are well-developed in conservation law and policy.
- The idea that an ecosystem is a 'entity' is equally valid to 'Indigenous science' – or might what otherwise be termed the 'first law' and science of Country – as to conventional (Cartesian) ecological sciences.

The responsiveness of law and policy to ecological theory is worthy of further elaboration. We focus on the contribution of conventional ecological science to issues of restoration.

Conservation law and policy has not yet to come to terms with ecological theory and concepts. It shows only a rudimentary understanding of restoration ecology. Restoration law and policy is itself in its early stages.[65] Crucially, restoration literature insists on the need to accommodate ecological science more effectively. 'Net gain' is a relatively hollow proposition without closer alignment of law and policy with ecological concepts and science.[66] 'Net gain' policy provides opportunity for better reconciliation of policy with science. For such reconciliation, certain key proposition need to be accepted and synthesized into law and policy.

The first of these is that ecosystems are not deterministic but dynamic. Causation may be complex, multi-scalar, affected by uncertainty, and may enable abrupt or 'non-linear' change. These properties affect both ecology generally and restoration ecology as a specific field. The model of trajectory may be central to ecological dynamics but even that needs to be treated with some caution: in the ecological context there may be multiple trajectories. Multiple and adaptive reference points maybe needed. Where ecosystems function in non-linear ways, change can be understood in terms of 'succession', 'regime change', 'shift', as well, potentially, as 'collapse'. Concepts such as 'thresholds' and 'tipping points' are important. These may be positive, such as in succession of ecological communities or where reintroduction of keystone species enables recovery cycles. Or change can be catastrophic, such as degradation leading to extinction or ecosystem collapse. Other 'transition dynamics'

[64] See eg Anand et al 'Ecological systems as complex systems: challenges for an emerging science' (2010) 2 *Diversity* 395, 404: 'The fact that ecological systems are neither completely predictable nor completely random is not surprising as few natural systems are. However, ecological systems have a substantial random or stochastic component and a worthwhile predictable component that is often masked by the stochastic one, which does make them challenging to study.'

[65] See eg Cliquet and Decleer 'Linking restoration science and law' in Akhtar-Kharavi and Richardson (eds) *Ecological Restoration Law: Concepts and Case Studies* (Routledge, 2019); McCormack 'Reforming restoration law to support climate change adaptation' in this same volume, 275-282

[66] Ibid

also occur in natural systems.[67] Ecological sciences provide a wider and richer canvas of terms and concepts with which it is likely law and policy will need to engage.

Notions of recovery and trajectory remain important in this context, as they provide overarching models of change and patterns of system behaviour. Those dynamics, however, are not necessarily simple or straightforward.

Secondly, the properties of 'healthy', 'recovered' or 'recovering' ecosystems are important factors informing law and policy. For example, exploration of these features can aid objective- and target-setting. Restoration, especially in urban areas, is not readily conceivable without reference to emerging concepts such as 'extinction debt' and 'ecological trap'.[68] Such concepts emerge from close scrutiny of ecological processes and dynamics, including at population and landscape scales. Similarly, theoretical underpinnings of ecosystem 'health' seem imperative to effective legal and policy design. These underpinnings are reflected in the SER recovery model. They include characteristics such as trophic complexity, connectivity, and biological diversity. Certain other characteristics are relevant to an effective legal and policy model of recovery (and hence 'net gain'), including resilience and adaptive capacity. These qualities need to be given their full ecological meaning in policy design. For example, indicia of resilience in urban ecosystems would likely mean measures of the social and biophysical capacity of ecologies to withstand significant disturbance or shock.

1.5.3 'Healing' and the cultural measure of environmental 'net gain'

The third basis of reframing environmental 'net gain' for the Yarra Birrarung relates to the cultural landscape and, specifically, the historic and ancient circumstances of the Birrarung as Wurundjeri Woirurrung Country.

This framing is strongly narrative, poetic and moral, as well as geographic:

> The Birrarung is a river of mist and shadows – the river and its environs are a living, breathing entity that follows Wurundjeri songlines and forms a central part of the Dreaming of the Wurundjeri… In sharing the benefits that the river provides, we must also share responsibility for preserving and restoring the well-being of the Birrarung…'[69]

It is based on 'reverence'[70] for Country. Cultural connection and agency is linked with, but not reduceable, to ecological restoration.[71]

Wurundjeri law of the river (first law) is recognised in Parliamentary law. This recognition is most clearly seen in the joint or 'bi-cultural' language of the river in the statute (that is, as 'Yarra River' and 'Birrarung') and evident in the definition of the river as a 'single living and natural entity'.[72]

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[67] Walker and Moral 'Transition dynamics in succession: implications for rates, trajectories and restoration' in Suding and Hobbs (eds) *New Models for Ecosystem Dynamics and Restoration* (Island Press, 2008)
[68] Cliquet and Decleer 'Linking restoration science and law' in Akhtar-Kharavi and Richardson (eds) *Ecological Restoration Law: Concepts and Case Studies* (Routledge, 2019)
[69] Wurundjeri Water Policy, 5
[70] Aunty Margaret Gardiner (pers comm, Birrarung Council Steering Group meeting, 18 September 2020)
[71] Freedman *Bulleen-Banyule Flats Cultural Values Study* (Wurundjeri Woiwurrung Aboriginal Corporation, 2020), [7.1], 238-245
[72] We refer to this term by the shorthand of the 'living' river in this report.

The framing of the legislation means that the concept of 'net gain' must include cultural (Wurundjeri Woiwurring) values and cultural indicia alongside indicators of improvement and 'recovery' in environmental condition consistent with restoration ecology. 'Clean' waters[73] and healthy populations of culturally indicative species (such as eel or freshwater mussels)[74] are examples of where cultural and environmental factors concur. 'State of the environment' reporting increasingly makes this approach a particular focus.[75]

Notions of 'custodianship' infer forms of moral, cultural and practical authority. In the context of 'net gain', custodianship means a role for the Wurundjeri in the *assessment* of 'gain', in establishing indicators of gain, in assessing impacts on or contributions to the health of the Birrarung more broadly, and in governance and decision-making in relation to the Birrarung. By extension, the development of reference models for ecosystem recovery and restoration need to include Wurundjeri Woiwurring content.

This 'custodial' function is partly expressed through Wurundjeri membership of the Birrarung Council. However, the Wurundjeri's authority in relation to the river goes beyond Council membership. 'The Wurundjeri role in a range of key activities, such as helping prepare the Yarra Strategic Plan and input to the Bulleen Banyule Precinct Structure Plan, arguably acknowledges the exercise of this cultural and moral authority associated with 'custodianship'.

We would suggest, then, that a third measure of environmental 'net gain' implicit in the Yarra Birrarung Act is what we might term a *cultural measure*. This measure relates to the cultural 'health' of the environment or, in the case of the Birrarung, the health and integrity of the 'living' river. In relation to restoration or recovery processes, this measure also encompasses the concept of 'healing' of Country. Interacting with Country in a manner enabling 'healing' is a measure of 'caring for Country'. A growing body of literature on Indigenous science and practice indicates proposes that cultural measures will typically include health of Country and the health of relationships to Country.[76] These may well overlap with or adapt other measures and values, such as those concerning recovery trajectories and restoration.[77]

The notion of a cultural measure therefore concerns not only the health of Country but also the health of *connection* to Country[78] and health of those responsible for it. For the Birrarung specifically, ecological and social indicators can be constructed for this measure of 'net gain', which relate to places,[79] species or landscape features,[80] plus ecological and cultural processes.[81]

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[73] Wurundjeri Water Policy, 7
[74] Freedman *Bulleen-Banyule Flats Cultural Values Study*, 239-240
[75] State of the Yarra and its Parklands Report (2018), 19
[76] Commissioner for Sustainability and the Environment (ACT) *ACT State of the Environment Report* (2019), 35-36
[77] See eg Bulleen-Banyule Flats Cultural Values Study (2020), section 7, 238-253
[78] As to indicators, see Bark et al 'Operationalising the ecosystem services approach in water planning: a case of Indigenous cultural values from the Murray-Darling Basin, Australia' (2015) 11 *International Journal of Biodiversity Science, Ecosystem Services and Management* 3 239
[79] For example, the health of Bolin Bolin billabong and other wetlands: see Wurundjeri Water Policy, 7, 9; Wurundjeri Narrap team (pers comm, 2 October 2020)
[80] For example, re-establishment of wildlife corridors and quoll habitat: Wurundjeri Narrap team (pers comm, 2 October 2020).
[81] For example, reintroduction of cultural burning practices: Wurundjeri Narrap team (pers comm, 2 October 2020).

Indicators of cultural 'gain' include those enabling connection to Country, revitalization of culture, and the continued building of Wurundjeri status. For example:

- Access to Country
- Re-establishing ceremony and education on Country
- Activities promoting cross-cultural connection to Country, conducted under Wurundjeri auspices
- Natural resource management on Country, such as cultural burning and cultural watering

These indicia can be given quantitative as well as qualitative expression.[82]

A key proposition of the emerging field of 'indigenous science' is the importance of measures of environmental conditions and environmental improvement. Conventional science is increasingly being synthesized with Aboriginal knowledge, producing pluralistic environmental knowledge and practice.[83] These can result in the bringing together of Aboriginal epistemic devices (ways of knowing), such as what has been referred to as 'deep time', with scientific models of environmental change or recovery,[84] . This synthesis can also create practical joint assessment and planning processes which bring together cultural and scientific models of environmental management.[85]

1.6 Bringing the 'frames' together 1: offsetting or 'transactional' strategies?

Informed by literature and practice, we have discerned three broad ways of approaching environmental 'net gain 'or, to use the terms of the project brief, three 'framing' devices for environmental 'net gain'.

They are not mutually exclusive conceptual tools. However, alongside commonalities and alignments, there are tensions, ambiguities and uncertainties in how they relate to each other, including in an application of 'net gain' in the Yarra Birrarung corridor.

For example, the prevailing approach of conservation policy as discussed earlier is to understand environmental 'net gain' through the 'transactional' device of offsetting. For the Yarra Birrarung, this approach means creating a scheme of quantitative valuation of environmental (and potentially cultural) characteristics of the river corridor which could then be traded off one against the other, with an assumption that this will achieve overall, long-term improvements. Alternatively, other environmental 'compensation' schemes could be

[82] See eg Sangha and Russell-Smith 'Towards an Indigenous ecosystem services valuation framework: A North Australian example' (2017) 15 *Conservation and Society* 3 255
[83] See 'Review of literature 3: 'Indigenous science' and cultural knowledge' below
[84] See eg Ann McGrath '"All things will outlast us": how the indigenous concept of deep time helps us to understand environmental destruction' *The Conversation*, 19 August 2020, https://theconversation.com/all-things-will-outlast-us-how-the-indigenous-concept-of-deep-time-helps-us-understand-environmental-destruction-132201
[85] See eg McKenzie et al *Cultural Flows Field Studies: Final Report* (MLDRIN, NBAN and NAILSMA, 2017), http://culturalflows.com.au/images/documents/Final%20report.pdf

adopted.[86] Offsetting or 'compensation' schemes can be integrated with wider conservation policies.[87]

The complex of relevant 'ecosystem services' potentially to be valued is diverse and can include terrestrial and/or in-stream habitat, water quality, flows, species assemblages or trophic complexity, connectivity. Given this complexity, it is likely that the many representative values would need to be 'bundled' and hence a relatively sophisticated model assembled in order for offsetting or compensation to be calculated. That approach is not unusual in environmental 'crediting' schemes at the landscape scale.[88]

Adapting an offset tool to contribute to a corridor-length recovery scheme could arguably be achieved, especially where representative values (expressed for example in 'credits' or 'scoring') reflect indicators of recovery and align with the overall 'vision' (reference point) for restoration and recovery. Existing offsetting schemes, such as those developed for threatened species management[89] or for native vegetation clearing,[90] would likely not be able to account for the full suite of values required for restoration models for the Yarra Birrrarung. Offsetting schemes are relatively purpose specific and cover only a confined set of values. For the Birrarung, a complex set of metrics would be needed. The evidence suggests that any such multi-credit, or multiple-metric scheme would need strong regulatory imperatives.[91] These would include such things as legal controls over degrading influences, such as stormwater inflows, biodiversity loss, or Aboriginal heritage damage.

In addition, a scheme properly aimed at ecosystem-wide recovery would need to account for past degrading influences, as a form of 'ecosystem debt'. An example of this in the Yarra Birrarung system would be extensive water diversions in the past (around 50% of natural flows[92]), for which, in principle, 'offsetting' 'credits' could be generated over, for example, the 50-year timeframe of the Yarra Birrarung 'community vision'. In practice, it is likely this approach would require a relatively complex ecological-accounting model capable of retroactively compensating for the loss of ecological function and integrity of the Yarra arising from large-scale dam construction for Melbourne's water supply. Monetarised 'credits' could be generated from past activity which would then be available for restoration actions, according to some form of equivalence as a form of 'gain' in the ecohydrological system.

This theoretical example of offsetting for the Yarra Birrarung does not deal with cultural (Wurundjeri) values in a proper and respectful manner. Potentially there is scope for cultural

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[86] See Simmonds et al 'Moving from biodiversity offsets to a target-based approach for ecological compensation' (2020) *Conservation Letters* 13:e12695

[87] See the example of 'net gain' under the proposed UK model for England: '"Net gain" example 2: The United Kingdom as a case study for managing net-gain and restoration: what does another jurisdiction tell us?' below

[88] See eg scheme for Willamette Basin in Oregon: Willamette Partnership *Developing the Willamette Ecosystem Partnership* (2008), https://willamettepartnership.org/wp-content/uploads/2014/09/Developing-the-Ecosystem-Credit-Accounting-System.pdf

[89] For example, EPBC Act offsets policy, see Appendix 2 below.

[90] See Appendix 2 below.

[91] See eg von Hase and Cassin *Theory and Practice of 'Stacking' and 'Bundling' Ecosystem Goods and Services: A Resource Paper* (Forest Trends, 2018), https://www.forest-trends.org/wp-content/uploads/2018/11/Stacking-Bundling-Resource-Paper-01-11-18.pdf; Willamette Partnership *Developing the Willamette Ecosystem Marketplace* (2008)

[92] DELWP *Long-term Water Resource Assessment for Southern Victoria: Basin-by-Basin Results* (2020), 116-124 ('Yarra Basin')

values to be given a quantified expression, based on indicators derived, for example, from custom or other accepted calculation.[93] The extent to which quantifiable measures of culture can be integrated into offsetting arrangements is problematic, given they are relatively abstract and difficulties in determining equivalence of values.[94] Although they could in theory be quantified, cultural values are typically highly place-based and not amenable to abstraction and equivalence. Compensation arrangements under native title law do provide a form of quantifying cultural loss associated with adverse impacts to Country.[95] Whether offsetting schemes can successfully apply such measures is presently uncertain but may need to be explored.

In principle, a discrete environmental offsetting scheme for the Yarra Birrarung, directed to generation of 'net gain' outcomes to achieve the Community Vision (and more specific performance objectives), could be devised. It would provide the type of quantitative, science-based measures typically used in environmental-accounting models. Such a scheme would, at the same time, likely be challenging to devise, time-consuming, expensive, complex, and not guaranteed to achieve the 'vision' and objects of the Act. Considering the environmental offsetting model is useful as it highlights these problems.

The 'framing' device of 'metrics', quantitative values and environmental-accounting measures used to inform 'net gain' in offsetting provides a known and familiar approach to environmental policy. While it is not without its uses, this framing is not particularly responsive to the specific statutory context of environmental 'net gain' in the Yarra Birrarung corridor.

1.7 Bringing 'frames' together 2: restoration strategies for environmental 'net gain'

1.7.1 Understanding 'net gain' begins with the scheme of the Act

In reconciling the various approaches to framing 'net gain' for the Yarra Birrarung corridor, the appropriate starting point should be the Act itself.

The broad intention of the Act is to achieve long-term improvement to the condition of the river. This outcome will be ecological, cultural and social improvement. This context for 'net gain 'differs from that of its common use in environmental or planning policy to date, where it has been focused on enabling development or resource use. Under the Act, net gain is embedded in a specific, high-level and long-term project for landscape change: the Act is directed to achieving the Long-term Community Vision and the aspiration of a 'healthy', 'living' river. The scheme of corridor planning supporting these outcomes suggests a leading role for a restorative framing of environmental 'gain'.

[93] See eg Mooney and Cullen 'Implementing the Aboriginal Waterways Assessment Tool: collaborations to engage and empower First Nations in waterway management' (2019) 26 *Australasian Journal of Environmental Management* 3 197

[94] See for example tensions between the 'ecological equivalence' method in the MDB, for assessing modelled ecological outcomes associated with SDLAM projects, and highly place-based cultural values associated with discrete Country across the southern MDB affected by those projects.

[95] *Northern Territory v Griffiths* [2019] HCA 7 *('Timber Creek Case')*; For a summary, see AIATSIS 'Timber Creek compensation case', https://aiatsis.gov.au/explore/articles/timber-creek-compensation-case

1.7.2 The primary object of 'net gain' – restoration

The proposition we advance here is that the framing of the Yarra Birrarung Act gives particular weight to trajectories of improvement best understood in terms of *ecological restoration*. Restoration is a principal *object* of 'net gain for the environment'. A key strategic measure of 'net gain' for the environment in this regard is *recovery* of natural systems and processes, with reference to existing localised conditions. The Yarra Birrarung traverses a range of environmental settings (urban-peri urban- rural) and bioregions but this is not an impediment to building the 'net gain' concept around the River's restoration. Urban ecological restoration is both an extensive field of practice and a subject of specific theorising.[96] There are currently restoration activities in the urban and peri-urban areas of the Yarra Birrarung corridor .

The geographic and regulatory space of restoration in the Yarra Birrarung corridor is provided for through the Yarra Strategic Plan and the 'Yarra Strategic Plan Area'. Land within the river corridor is, under the present reading of environmental 'net gain', intended as the focus of restoration strategy or, to put this another way, a conservation policy that is also a restoration policy.

Ecological restoration recognises that change and improvement occur in socio-ecological systems. Key 'inputs' and factors include management of natural landscapes through human influences over, and interventions into, natural systems. This occurs alongside the inherent characteristics of natural systems, and is a dynamic that has occurred for millennia in Australian landscapes. Ecological restoration is as much art as science. Dynamics of human intervention already occur routinely, via regulated and permitted environmental impacts, although these are part of a largely ad hoc trajectory of ecosystem decline rather than conscious or intended trajectories of improvement.

'Environmental net gain' can part of intentional 'adaptive restoration'.[97] Restoration can set the primary frame for 'net gain' and establish a structured approach to 'gain'. What might be included in this structured approach?[98]

Plan for recovery.

Recovery can be understood as, in principle, 'ordered' and cumulative outcomes measured against the highest level of restoration attainable. Across a relatively large and diverse landscape such as the Yarra Birrarung, recovery can be uneven, disparate, and/or diffuse. Equally, it can potentially be targeted and strategic. A form of 'staged', multi-decade program of recovery is implied in the Yarra Strategic Plan.

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[96] See literature review below on 'green' and 'environmentally sensitive cities'. See also eg special issues on urban ecological restoration in *Nature and Culture* (2010) Vol 5 Issue 3: Gobster 'Introduction: urban ecological restoration' (2010) 5 *Nature and Culture* 3 227, and *Ecological Restoration* (2008) Vol 26 Issue 3: Ingram 'Urban ecological restoration' (2008) 26 Ecological Restoration 3 175.

[97] Zeller et al 'Shifting restoration policy to address landscape change, novel ecosystems, and monitoring' (2012) 17 *Ecology and Society* 4 36; Zedler 'Ecological restoration: guidance from theory' (2005) 3 *San Francisco Estuary and Watershed Science* 2, https://escholarship.org/content/qt707064n0/qt707064n0.pdf?t=q5auv9

[98] For a detailed scheme for planning restoration projects, see also SERI *Guidelines for Developing and Managing Ecological Restoration Projects* (2nd ed, 2015), https://cdn.ymaws.com/www.ser.org/resource/resmgr/custompages/publications/ser_publications/Dev_and_Mng_Eco_Rest_Proj.pdf

Taking the 'SER 5 star recovery system' (see 1.5.2) as a starting point, recovery in any specific sector or part of the river landscape can be assessed against broad qualitative criteria.[99] These include, in ascending order:

- ongoing deterioration prevented, planning for recovery, opportunities for recovery
- threats beginning to be managed, characteristic biotic communities present, improved connectivity
- some representative biotic assemblages, ecosystem function and connectivity evident
- substantial complexity and ecosystem structure, improved connectivity and adjacent threats managed
- representative biotic system, trophic and structural complexity, high degree of cross-boundary dynamics and resilience, appropriate disturbance regime, long-term management.

There may be variations to this recovery scheme based on ecological and cultural insights. Nevertheless, this model shows the value of a recovery assessment framework for the Yarra Birrarung corridor. Such an assessment framework can be applied to the corridor at various scales. It can provide both baseline and subsequent analysis.[100]

Prepare reference models.

The Community Vision sets high-level aspirations for the river corridor. To achieve these aspirations, specific reference models (or future states of recovery) are required. Reference models may include intact sites and often do. However articulating an intact site may be challenging in urban ecosystems, given damage that has occurred over a long period. But even in urban ecosystems such as the Yarra Birrarung, there will usually be native reference systems available to draw on, often associated with waterways, coasts or (remnant) protected areas.[101] Reference models should take into account important opportunities and pitfalls in ecological dynamics,[102] such successional change, localised extinction debt (time delays between impacts on a species and the species' ultimate disappearance), cascading effects, or conditions enabling resilience. For the Yarra Birrarung established 'benchmarks' based on Ecological Vegetation Classes (EVCs) will provide some insights into past environmental states. Historical information can be important. Recovery of ecological function in adjacent urban areas can be important to supporting restoration based on reference models in the target area.[103]

To measure landscape-scale 'gain' it is likely that multiple reference models will be needed. Reference models may be prepared at corridor and localised scales, with a view to their integration in a 'nested' manner and in accordance with various ecotones or bioregions. The strategic planning scheme for the river corridor (in the YSP) lends itself to organising

[99] SER *International Restoration Principles and Standards*, 41, Table 3; see also Table 4, 42-43 for key attributes framing ecological indicators.
[100] See Ecological Recovery Wheel, SER *International Restoration Principles and Standards*, 44; reproduced at Appendix 3 of this report.
[101] In the alternative 'Where biological degradation cannot be reversed, the next best alternative would be rehabilitation to the highest practicable ecological functionality, with as high as possible similarity to the reference ecosystem': SER Australia *National Standards for the Practice of Ecological Restoration in Australia* (2018), 5.
[102] See eg Suding et al 'Alternative states and positive feedback in restoration ecology' (2004) 19 *Trends in Ecology and Evolution* 1 46; Kirkman et al 'A dynamic reference model: a framework for assessing biodiversity restoration goals in a fire-dependent ecosystem' (2013) 23 *Ecological Applications* 7 1574
[103] See SER Australia National Standards for the Practice of Ecological Restoration in Australia (2018), 34-35

reference models at different scales. The scheme can set out policies for geographic coverage and priority of reference models. Reference models, for example, could be coordinated with localised planning. Forthcoming UK environmental legislation will include provision for 'local nature recovery strategies '.[104] Formulation of reference models can be an important part of strategic planning enabling 'net gain'.

Reference models should y integrate cultural knowledge, practices and norms. For the Yarra Birrarung, this requires reference models for Country that are prepared for the cultural landscape. Corridor-wide strategic planning can set policies for integration of cultural knowledge with reference models.[105]

Set targets.

The SER International Principles and Standards identify targeted restoration as implementing a reference model to achieve an outcome, with goals and objectives for medium and longer term outcomes.[106] A more common approach to target-based conservation is to treat targets as quantified expressions of goals, reflecting minimum or maximum preferred thresholds.[107] Target-setting can include a wide range of social and political as well as ecological considerations.[108]

The SER approach suggesting a reference model is itself a target can be situated alongside 'incremental' targets which inform 'SMART' performance objectives. For the Yarra Birrarung corridor these would be 10-year targets. 'Net gain' in the Yarra Birrarung context can include *targeted recovery* over a series of 10-year 'stepping stone' horizons, applying to restoration projects or a complex of projects, in accordance with a recovery schema such as the '5 star recovery method'. Recovery targets might include targets for removal of harms or threatening processes, as well as positive restoration indicators.

Target-setting should be driven by science and other considerations appropriate to the attainment of recovery goals. This should include cultural landscape influences and knowledge.

How a target based approach could look

Science-based targets for 'net gain' in the Yarra Birrarung could include targets for ecological connectivity or removal of degradation threats, alongside targets for reinstating cultural burning on Country with attendant ecological, cultural and social contributions to recovery. Targets based on scientific consensus and Aboriginal-cultural drivers provide authoritative, independent bases of inputs.

Multiple local reference models might be used, given the diversity of environmental conditions (ecotones) across the Yarra Birrarung corridor. Target-setting might extend to

[104] *Environment Bill 2019* (UK), cll 95-100; see Case study 2 below.
[105] The Bulleen-Banyule Flats CVS provides a useful comparison. That study elicits detailed cultural knowledge of a localised section of the river corridor, informing regulated management of that area (by way of structure planning). While not directly integrated into ecological planning, it can be seen how the cultural knowledge base could be integral to preparation of a reference model for ecosystem planning and recovery.
[106] See also SER Australia National Standards for the Practice of Ecological Restoration in Australia (2018), 4
[107] See eg Carwardine et al 'Hitting the target and missing the point: target-based conservation planning in context' (2009) 2 *Conservation Letters* 3
[108] Doherty et al 'Expanding the role of targets in conservation policy' (2018) 33 *Trends in Ecology and Evolution* 11 809

the quantum of restoration projects or effort within overall corridor objectives within any specific planning period.

Target-setting for restoration will have to contend with a series of important policy considerations. For the Yarra Birrarung these may arise from the Yarra Strategic Plan. They include, for example, developing the framework of scientific and cultural values indicative of 'gain' (recovery), geographic priorities and distribution of projects, organisational needs, and aligning Yarra Birrarung targets with other environmental actions and investments.[109] A science-led and Country-framed approach to targets can inform overall strategy.

Link 'individual actions and policies' to 'gain' through specific recovery plans.

The 'net gain' imperative under the Yarra Birrarung Act confers responsibilities on actors, including policy-makers, when impacting on the Yarra Birrarung corridor. 'Individual' actions and policies are referred to. The wider framing of 'net gain' of principal interest in this report concerns restoration and recovery generally. The conduct of policy-makers and other actors should be connected at the level of specific decision-making. It should be mandatory to prepare and implement specific recovery plans to cover 'individual actions and policies'. Required content for such plans could include both quantitative elements (such as biodiversity 'credits', however devised) and qualitative responses to specific conservation needs in the river corridor.[110]

Manage barriers.

There is substantial inertia in legal and policy regimes. This applies equally to the Yarra Birrarung corridor as elsewhere. Notwithstanding the important function of the Yarra Birrarung Act in seeking to overcome fragmentation of legal and regulatory arrangements for the river corridor, it likely remains the case that a wide range of existing rules, practices and decision-making frameworks[111] present potential barriers to alignment of decision-making with restoration. Delivering 'net gain', via restoration projects and actions, requires overcoming such barriers.

At the statutory decision making level, a range of actions would need to be designed and delivered with respect to public lands in the Yarra Birrarung corridor (Yarra River land) in order that restoration programs, enabling 'gain', could be delivered. These could include regulations in relation to Crown lands,[112] preparation of relevant management strategies,[113] agreements in relation to works or activities,[114] or management plans[115] relating to biodiversity or water management.

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[109] The alignment question will likely be relevant to pathways for integrating ecological 'compensation' arrangements into target-based recovery, which has been proposed as a model for responding to development and project-based impacts beyond offsetting schemes: see Simonds et al 'Moving from biodiversity offsets to a target-based approach for ecological compensation' (2019) 13 *Conservation Letters* 2 e12695. Issues of policy, conservation and geographic alignment of recovery and target-setting are also illustrated in *Environment Bill 2019-21* (UK), See Case Study 2 below.

[110] Compare eg the requirement for a 'biodiversity gain plan' under *Environment Bill 2019-21* (UK), Schedule 14, Part 2, cl 14

[111] In relation to legal and regulatory schema applying to the Yarra Birrarung corridor, see Appendix 1.

[112] See *Crown Land (Reserves) Act 1978* (Vic), s 13

[113] See eg *Parks Victoria Act 2018* (Vic), s 46

[114] For example, works undertaken by nongovernmental organisations delivery of restoration projects on public land or land management practices undertaken by Traditional Owners on public land (such as burning).

[115] See eg *Flora and Fauna Guarantee Act 1988* (Vic), Part 4 Div 3

At the institutional level, barriers to 'gain' can include policy on distribution of resources (such as provision of water to cultural or environmental flow regimes) or administrative practices (such as using agreement-making in order to enable collaboration between agencies and community organisations).[116]

Legal and behavioural barriers to environmental 'gain' can include land tenure fragmented into public and private (freehold) estates. That type of impediment may need to be tackled by shifting landowner behaviours and engagement, financial incentives or use of regulatory tools (such as planning).

To achieve 'net gain' it is necessary to establish an enabling environment. In part, consequential amendment to governing legislation for 'responsible public entities' intends to do just that.[117]

Organise for recovery.

The social bases of ecological restoration are fundamental. Restoration projects are typically built from existing organisations, social and community actors, networks, collaborations and relationships. These foundations are as crucial to measurable recovery as 'objective' factors such as intervention into natural systems. They see landscapes as socio-ecological systems.

Effective programs and projects have the characteristic of a movement. All key actors involved in restoration should have agency, enabled by appropriate structures. For example, landscape restoration may involve, as typical key actors, private landowners, public land agencies, community organisations and NGOs (civil society), Aboriginal organisations, technical and scientific experts, and statutory authorities. There is effectively a form of distributed and shared authority for restoration and recovery across these actors. This can be given effect through planning, design of the restoration scheme itself, agreement-making, or other means. In the Yarra Birrarung context, governing legislation establishes the imperative for a collaborative approach, such as through principles of participation. The organisation and collaboration required for restoration schemes can be measured through customised indicators.

1.7.3 Using science based 'tools' for restoration

Scientific and technical inputs into restoration projects are important. These function in myriad ways. Science will guide models and concepts of natural systems, construction of reference models, planning, assessment and analysis, goal-setting and target-setting, hypotheses and reporting on outcomes. Restoration will be informed by various scientific disciplines, as well as interdisciplinary approaches.

Ecological sciences will be prominent in restoration approaches. This guidance will include technical measures, such as metrics designed to inform baselines, target-setting, assessment processes, project design, and performance outcomes.

[116] See also Wurundjeri preference for intangible heritage agreement-making with public agencies: Bulleen-Banyule Flats Cultural Values Study (2020).

[117] In respect to legislation governing powers and functions of RPEs, additional obligations to implement binding provisions of the Yarra Strategic Plan and 'have regard to' any other provisions relevant to those powers and functions (as well as the Yarra protection principles) were incorporated by amendment.

Sciences will provide an information necessary to effect recovery, mobilise resources and develop recovery strategies.

Scientific knowledge and scientific practise will be important in a number of ways, as set out below.

Science informing reference models.

Science plays a crucial role in constructing reference models for restoration projects and strategies. A range of scientific disciplines and cross-disciplinary knowledge will likely be relevant. For example, for wetland restoration projects hydrological, biological and geomorphological inputs would typically be needed, often alongside historical or archaeological sources.[118]

Science informing the indicia, interim targets and objectives.

Restoration relies on organisation. Restoration policies, programs and projects are built upon an 'infrastructure' of design and planning. Science informs design and content (for example, measurable inputs) in this 'infrastructure' of restoration planning and action . Reference models are part of this infrastructure, but it is also necessary to establish goals and objectives for specific projects and broader programs at the landscape-scale. Goals and objectives should be developed using SMART principles, (specific, measurable, achievable, relevant and time-bound). Formulating baselines for gauging recovery is also an intrinsic part of the exercise.

So scientific knowledge plays a key role in assessing performance through its role in constructing measures, indicators, and targets, enabling outputs and monitoring outcomes.

There may be common indicia and measures across entire landscape-scale projects, such as habitat restored or hydrological patterns reflective of reference states. Additionally, there may be indicia and measures responsive to localised conditions, such as cultural outcomes corresponding to specific lore with scientific variables (for example, culturally important species) or trophic or successional needs in specific ecosystems. Science can contribute to recovery planning through a refined or 'bespoke' device for constructing 'gain'. For example, floodplain restoration may have, along a particular reach, a series of indicia of recovery, ranging from geomorphic[119] to eco-hydrological,[120] for which science-based and quantifiable measures can be constructed.

Science shaping programs and projects.

The 'infrastructure' of the planning, implementation and assessment of recovery will therefore have its discrete 'architecture' of programs and projects, depending on specific circumstances. For the Yarra Birrarung corridor, the 'architecture' of planned recovery might include discernible projects and programs, each with their own design and principles, within 'nested' recovery strategies for the four 'reaches' and for the river corridor as a whole.

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[118] See eg Bachmann 'The role of historical sources in the restoration of long swamp, Discovery Bay, Victoria' (2020) 21 *Ecological Management and Restoration* 1 14, http://natureglenelg.org.au/wp-content/uploads/2020/04/Bachmann-M.-R.-2020-Role-of-historical-sources-in-the-restoration-of-Long-Swamp-with-Appendices.pdf

[119] For example, removal of artificial barriers to lateral floodplain connection, or re-establishment of complex bathymetries through channel 're-snagging'.

[120] Such as flow targets directed to breeding signals, or flow management directed to reduced turbidity outcomes.

Current science-based platforms, such as 'strategic management prospects', provide inputs into this restoration 'infrastructure' and 'architecture'. However, designated values underpinning those platforms rest on a small but important set of variables. Depending on the overall restoration policy for the Yarra Birrarung corridor, a wider or different set of science-based inputs may be appropriate. For example, in addition to habitat, connectivity or threatened species considerations, restoration priorities may require incorporation of eco-hydrological metrics.[121] Social variables (such as indicators of community involvement, health or organisational outcomes) may be significant. For the Yarra Birrarung, cultural categories will be important.

Science as a vehicle for agency.

Sometimes science will lead in the design of recovery efforts, sometimes science will defer to other factors, such as policy or expediency. The role of science can result from a 'dialogue' embedded in strategic planning for restoration. There are also circumstances where science serves as an agent for important, if incidental, outcomes and processes in restoration strategy. For example, science is a vehicle of knowing and, through restoration, science can open up, revise, and innovate *processes of knowing*. The growing body of experience and practise bringing together scientists and traditional owners to share knowledge and build enhanced, knowledge systems illustrates this role. Similarly, harnessing local communities for restoration efforts enables science to stimulate community education and development. The 'citizen science' approach is an exemplar of science used in restoration as a vehicle to activate community as well as extend scientific knowledge

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In other ways, science can be used as a basis for building relationships and connections. These can be connections across social groups, such as collaborations between scientists and traditional owners, or collaborations between landowners, scientists and community organisations. Alternatively, science can be used as means for (re)connecting people to places, such as where scientific programs enable access to and connection to Country, or where science contributes to transformation of land or places through recovery processes and thereby changes connections to places.

Science informing models of ecological dynamics and systems

Science informs concepts and theory of restoration and recovery. Elsewhere in this report, we have referred to the importance of restoration being properly informed by the science of restoration ecology. The scientific base of restoration policy and practice must respond to the rich theoretical legacy of ecological sciences, including insights into the inherent dynamism and complexity of ecosystems, and the extensive 'toolkit' of scientific models and concepts these disciplines provide.

It may be that restoration programs for specific settings and in specific circumstances are sufficiently informed by relatively simple, straightforward or deterministic models of recovery. For example, short- or medium-term conservation projects might focus on recovery outcomes arising from weed removal and legal security of a site for conservation, in order to allow native vegetation to grow or increase native species diversity. However, a *restorative outcome*, more akin to rehabilitation, can be achieved. If a *restoration outcome* based on a

[121] For example, designing and implementing metrics of stormwater flows will be crucial to creating effective ways of measuring ecohydrological threats and benefits of many actions in urban and urbanizing catchments: see eg Burns et al 'A landscape measure of urban stormwater runoff effects is a better predictor of stream condition than a suite of hydrologic factors' (2015) 8 *Ecohydrology* 1 160.

targeted reference model is intended for the site, then wider, more sophisticated ecological models and metrics need to be used. It may be that ecosystem recovery requires 'keystone' species to be reintroduced, which will support more self-sustaining ecological processes (for example, digging marsupials affecting soil structure and overall ecosystem health[122]). The ecological models for restoration in this case would need to take into account relative complexity in ecosystem services. Appropriate metrics may need to include indicators of reintroduction success, soil structure health, and/or shifts in species richness.

The legal and policy frameworks intended to implement 'net gain 'should reflect ecological theory and seek recovery. For example, a policy based on 'net gain' could

- seek to reduce the 'extinction debt' of threatened species and ecological vegetation classes in the Yarra Birrarung corridor
- set numerical and spatial targets for connectivity or trophic complexity
- reflects the importance of 'keystone' species in urban ecosystems,[123]
- seek ecosystem resilience in the river corridor
- recognise non-linear change, such as ecological succession or potential 'regime shifts'.

New or targeted metrics may be needed to best reflect patterns of change. Trajectories of change may not be straightforward, especially in the urban context.[124]

Metrics and strategy responsive to ecological theory: the example of ecological memory

'Ecological memory' is the capacity of past ecosystem conditions to influence present and future conditions. Ecological properties are embedded in remnant ecological conditions and resources and reflect past disturbance, current condition and future trajectories.[125] 'Ecological memory' can help us measure current ecological conditions in modified landscapes and inform the potential for 'gain' and recovery in those conditions.

The concept of ecological memory is fundamental to understanding spatial resilience and self-organization, the relationship between geomorphology and ecology, the renewal cycle in succession, landscape dynamics, invasive species, outbreaks, and urban ecosystem management. Because it includes remnant resources, such as plants, animals, and the soil seed bank, ecological memory is likely to affect system development following disturbance.[126]

[122] See eg Davies et al 'Ecosystem engineering by digging mammals: effects on soil fertility and condition in Tasmanian temperate woodland' (2020) 6 *Royal Science Open Science* 180621; Fleming et al 'Is the loss of Australian digging mammals contributing to a deterioration in ecosystem function?' (2014) 44 *Mammal Review* 94

[123] For example, the role of powerful owl as an apex predator in urban Melbourne, especially along waterways: Carter et al 'Joining the dots: how does an apex predator move through an urbanising landscape' (2019) 17 *Global Ecology and Conservation* e00532, https://www.swifft.net.au/cb_pages/swifft_seminar_notes_-_urban_ecology_23_july_2020.php#powerful%20owl

[124] See eg Zedler and Calloway 'Tracking wetland restoration: do mitigation sites follow desired trajectories?' (1999) 7 *Restoration Ecology* 1 69

[125] Sun et al 'Quantifying ecological memory during forest succession: a case study from lower subtropical forest ecosystems in southern China' (2013) 34 *Ecological Indicators* 192, 192

[126] Ibid

Ecological memory can be contained in ecological features such as seed banks, remnant species populations, geology, soil composition, or geomorphology. This 'memory' can be crucial to construction of ecosystem reference models or hypotheses of system behaviour, such as successional models for particular ecosystems.

Ecological memory is important for contextualising and understanding ecological change. It can be quantified through ecological sciences, building on appropriate biophysical indicators.

In Sun set al's study of forest succession in southern China, indicators used included vegetation, soil biota, seed banks, birds, light, and soil minerals, considered across various successional stages of the forest ecosystem. These authors concluded that ecological memory increased over successive stages in the forest ecosystem, as the various ecological features accumulated in a non-linear and geographically variable manner.[127]

Ecological memory is, therefore, a calculable quality in ecosystems and can be applied to ecosystem restoration.

Science informing recovery techniques and practices.

The Australian National Restoration Standards include as a defining principle of ecological restoration that 'restoration science and practice are synergistic'. This proposition can be taken to mean science (and other forms of organised and structure knowledge) inform practise and vice versa. The science that informs restoration practice will likely include a variety of methods, traditions and formalities, ranging from time-bound field experiments through to structured long-term observational data and insights. Across the spectrum of conventions in scientific practice there is a logical and methodological thread concerning structured and accumulated knowledge.[128] As Indigenous science attests, this spectrum can also traverse styles and modes of language and communication: not only the mode of technical rationality (Cartesian reasoning) but narrative and poetic modes of lore and custom.

1.7.4 Restoration to be a strategy for 'healing' Country and bringing together recovery and revitalisation

Just as ecosystem restoration can be guided by science, it can similarly be guided by cultural knowledge of Country. This proposition is not platitude but rather a recognition of 'synergies' between ecological sciences' understanding of ecosystems as organisms and Aboriginal understanding of Country as a 'living entity'. 'Net gain' is to be measured using the concept the Birrarung as a 'living entity', a functioning socio-biophysical system. Restoration can be viewed as enabling the 'recovery' of both. 'Recovery' and 'healing' are both apt metaphors for the soundness and integrity of the geographic 'body'. The Yarra Birrarung Act recognises Wurundjeri customary law of the river, that is, the personified, 'relational' model of the natural system.

[127] Ibid, 202

[128] 'Science is not the preserve of professional scientists – rather, it is a logical approach to thinking based on systematic, repeatable observations and, ideally, controlled experiments to test a prediction (hypothesis). To optimise our ability to gain knowledge from restoration practice, science-practice partnerships should be encouraged. Such partnerships will help optimise potential for innovative restoration approaches to provide reproducible data and robust guidance for future activities'. SERA *National Standards for the Practice of Ecological Restoration in Australia* (2nd ed, 2018), 16

While scientific and amenity values invested in the Yarra Birrarung reflect 'western' cultural models of nature, arguably that set of values is meagre when compared to the Wurundjeri understanding of cultural landscape. This is in part because the latter is connected by ancestral ties to rich, embedded cultural values, pre-dating degrading processes, and reflected in Wurundjeri lore/law of the river. Science and restoration strategies seek to recover natural ecologies attached to those landscapes. Cultural 'gain' can overlap with restoration models,[129] but restoration in cultural terms can also extend and deepen restoration concepts and therefore models of 'gain'.

Case study: Bringing Indigenous culture and science together

The Bulleen-Banyule Flats Cultural values study employs cultural knowledge alongside knowledge generated through various social-science disciplines. Quantification of cultural values (or the production of cultural metrics) is illustrated through emerging examples of cultural assessment methods. Moreover, methods for integration of 'ecosystem services' models with management and restoration of Country are now well-advanced.[130]

Landscape restoration concerns the cultural landscape

As the above suggests, 'net gain' constructed around models of ecosystem restoration must come to terms with the conjoint ways of knowing the Yarra Birrarung corridor. Those two ways of knowing (epistemic models) are both accommodated in the Yarra Birrarung Act (the bicultural, 'living entity'/Birrarung approach) and this, by implication, authorises a Wurundjeri leadership role. Geographies and strategies of restoration in the Yarra Birrarung corridor may favour ecological projects but 'net gain' *for the cultural landscape* may divert from or go beyond indicia of recovery of natural systems. For example, restoration of the cultural landscape may incorporate recovery of Wurundjeri connection to Country (and, as appropriate, bring others into that task) and give alternative expression to recovery objectives. Hence, tangible and intangible heritage outcomes may be a focus of 'gain'. Other nominated outcomes that are social, legal or practical in nature might also be integrated into calculation of 'gain', as reflected in indicative factors set out below.

Caring for and healing country

Caring for and healing Country should be central to the strategic planning and programmatic work underpinning 'net gain'. Wurundjeri content – and/or the space for developing Wurundjeri input into Yarra Birrarung restoration – can be a key part of restoration strategy. Embedding cultural 'gain' should reflect preferred approaches expressed by the Wurundjeri. Appropriate policy and protocols can then be developed. Formal agreement-making is one pathway. Such agreement-making can occur with the State directly, such as through heritage agreements or *Traditional Owner Settlement Act* agreements. Given the unique position of the Wurundjeri as a Responsible Public Entity under the Yarra Strategic plan, it is arguable that appropriate agreement-making should occur with other RPEs. Where devices such as

[129] Bulleen-Banyule Flats CVS, Recommendations, 238-245

[130] See eg the synthesis of ecosystem services model and cultural priorities in Bark et al 'Operationalising the ecosystem services approach in water planning: a case of Indigenous cultural values from the Murray-Darling Basin, Australia' (2015) 11 *International Journal of Biodiversity Science, Ecosystem Services and Management* 3 239; Sangha and Russell-Smith 'Towards an indigenous ecosystem services valuation framework: a North Australian example' (2017) 15 *Conservation and Society* 3 255

localised 'recovery strategies' or 'recovery plans' emerge as tools for restoration, these instruments should also include Wurundjeri content, innovation and models of cultural expression of 'gain'. For example, re-establishing restorative land management or hydrological regimes (cultural burning or cultural flows) can be done in forms which reflect Wurundjeri connections and preferences, and with the express intention of 'healing' Country. In facilitating outcomes for Country, conventional planning tools and scientific models (such as formal indicators, benchmarks, targets or assessments) can often be used.

Reinforcing connection to country including being on country and access to it.
Restoration in the cultural landscape may well be frustrated by the physical and practical extent of change and degrading influences. The Yarra Birrarung is an urban river after all. But restoration may also be frustrated by the extensive displacement of Traditional Owners from important parts of Country. Colonisation effected loss of connection to Country. Re-establishing this connection , along with access to Country, can be a key indicator of cultural 'gain'. Achieving the outcome of physical connectivity to Country is complicated by tenure (land ownership). For public lands, management regimes have not been set up to accommodate connecting and caring for Country. This issue overlaps with that of 'managing barriers' as discussed above (section 1.7.2), In both ecological and cultural domains of restoration, current management (including rules of tenure) may illustrate what Ben Richardson calls the 'dead hand of grandfathered uses'.[131] Cultural gains, may enable ecological gains too, for example where access to Country and the right to manage Country for its 'health' achieves natural recovery and regeneration.

(Re)introducing cultural practices relevant to healing: fire, water, keystone species.
An obvious point of intersection between restoration ecology and 'caring for Country' can be found in natural resources management. The Wurundjeri, like many Aboriginal organisations, undertake substantial and growing natural resource management (NRM) activities. This allows for continued or re-established cultural forms of land and resource management, consistent with Aboriginal models and relationships to Country, and serving multiple outcomes. Ecosystem outcomes co-exist with economic, social, pedagogical, health and cultural outcomes.

The Wurundjeri's Narrap team expressed a clear desire to apply Aboriginal-led NRM practices on Country. These include cultural burning regimes and wildlife corridor restoration. Such practices create good ecological outcomes, building the authority of cultural models, and enabling learning and confidence of youth. Cultural burning models have taken on national prominence as a way to achieve measurable NRM, cultural and economic outcomes. Cultural management of water is emerging as a comparable field of NRM practice. Achieving measurable recovery outcomes through cultural watering schema can potentially lead to multiple environmental and related 'gains'. However such contributions to restoration targets need to be mindful of the complex, sometimes difficult, regulatory web to be negotiated.[132]

Restoration and cultural measures of 'gain' must reflect Wurundjeri agency.

[131] Richardson 'Timescapes of ecological restoration' in Akhtar-Khavari and Richardson (eds) *Ecological Restoration Law: Concepts and Case Studies* (Routledge, 2019), 67
[132] See Nelson et al *Cultural Flows – A Multi-Layer Plan for Cultural Flows in Australia: Legal and Policy Design* (MLDRIN, NBAN and NAILSMA, 2018), http://culturalflows.com.au/images/documents/Law%20and%20policy.pdf

Agency is indicative of authority (power) and know-how (technique). Agency is a hidden assumption in management of landscapes, as well as in the technical devices and policies informing that management. For example, conventional models of environmental 'net gain' used in biodiversity policy or offsetting tacitly reflect the agency of technical specialists, scientists, decision-makers and development actors. Where measures of 'gain' relate to the cultural landscape, they will reflect cultural values and priorities. These values may well focus as much on recovery of cultural responsibilities, connections and uses of the landscape as on its biophysical restoration.[133] 'Gain' in the cultural landscape is a measure of *whose* values are influential, *how* relevant values are designed and implemented, and *what content* is included in those values. For the Yarra Birrarung corridor, the mandate for restoration models and indicia of 'net gain' to reflect Wurundjeri agency and values can be found in the concept of custodianship contained in the Community Vision.

Processes by which values, indicators or targets representative of Country and relationships to Country are built also reflect agency.[134] These processes correspond to cross-cultural or pluralistic measures for restoration. They can be understood in terms of lore and cultural practices attached to landscapes, alongside scientific indicia of recovery.[135] Measures of agency can be direct, such as how participants perceive influence, or indirect, such as through proxy indicators for that influence.

Respect and 'reverence' for the Birrarung and Country: cross-cultural normative change.

The Yarra Birrarung legislation provides all Victorians with the opportunity for progress towards reconciliation of 'settler' society and State with 'first law' and with Wurundjeri sovereignty. 'Settler' society is only slowly coming to terms with the concept of biculturalism. The framing of the Act is an important development in this respect. For Wurundjeri the Birrarung is revered and it has ancestral (ancient) and existential links. This type of framework is common to Aboriginal people across the continent.' Net gain' cannot solely be explained as the change in environmental condition but must also focus on the evolving attitudes, norms and behaviours toward the Birrarung over time. This proposition reflects the need for indicia of 'gain' which reflect broadening acceptance of the bicultural model of the river. These indicia should reflect growing public and institutional support for or identification with the cultural landscape. They can also include changes in names and stories attached to the landscape. Indicia should be practical, and can include indicia of Wurundjeri influence in relevant decision-making. 'Gain' is a measure of *weight* given to the Wurundjeri landscape and to custodianship.

1.8 The Yarra Birrarung and policy principles for reframing environmental 'net gain'

This report has sought to consider closely the concept of 'net gain for the environment' through scrutiny of three relevant pathways for its construction and measurement:

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[133] Lyver et al 'Key biocultural values to guide restoration action and planning in New Zealand' (2016) 24 *Restoration Ecology* 3 314

[134] Compare Nursey-Bray et al 'Having a yarn: the importance of appropriate engagement and participation in the development of Indigenous driven environmental policy, Queensland, Australia' (2009) 10 *Indigenous Policy Journal* 3 1, http://www.academia.edu/download/51112157/Having_a_yarn_The_importance_of_appropri20161229-20612-kk77x0.pdf

[135] See eg Walker et al 'Kaitiakitanga, place and the urban restoration agenda' (2019) 43 *New Zealand Journal of Ecology* 3 1

- Quantitative, especially as reflected in scientific methods;
- Qualitative, as reflected in models of ecosystem restoration and recovery; and
- Cultural, as established through relationships to Country and care for those relationships and Country itself.

Interrogating the 'net gain' concept reveals that it can best be understood as a term of environmental change through the lens of restoration, albeit under the direct and active influence of the cultural landscape and through adaptation and application of a broad range of scientific, technical and policy devices.

In this way, the framing of environmental change and measurable improvement benefits from:

- A rich ecological theory and science
- An ordered and structured theory of change (recovery)
- Express recognition of and alignment with the cultural landscape
- A strategic approach
- Technical and science-based tools for measuring and assessing change
- Extensive scientific and technical knowledge of the relevant (Yarra Birrarung) urban landscape
- Recognition of the role of agency in change.

The concept of 'net gain for the environment' must be considered in the contextual setting of the scheme and objects of the Yarra Birrarung legislation.

While concepts of 'gain' already inform environmental and conservation policy, it is not clear how that 'gain' is actually to be achieved or what it will look like. The Yarra Birrarung scheme provides a vision of what 'gain' may look like in the real world. It provides a policy framework for landscape-scale restoration adapted to the unique circumstances of the Birrarung.

As this report seeks to highlight, the theory and practise of ecological restoration is adaptable to particular circumstances, well-informed by existing examples and lessons, underpinned by extensive theoretical base, and ought not to be confused with nostalgia. It is a marriage of social agency and intent with geography and nature.

The concept of environmental 'net gain', using a restoration-type approach, is *not so much a goal as a program*. The use of the term in existing policy, such as biodiversity offsetting, is usually to set out an overarching goal for that policy. The goal typically enables development to proceed, on condition of compensatory contributions toward the goal. Ecological compensation (offsetting) is at best loosely tied to a plan or strategy for environmental change. It usually does not include a plan to mobilise communities or affected populations for tasks of recovery. What 'net gain' can contribute in the Yarra Birrarung context is an ordered approach to and plan for landscape change, using the Yarra Strategic Plan as a platform. The strongest approaches draw on collaborations between restoration ecology, science and community. They also seek to re-centre Country and its custodians to be at the heart of the change process.

1.9 Where to next?

1.9.1 From 're-framing' to policy and practice?

Primarily, this report is directed to conceptual challenges posed by the idea of environmental 'net gain'. It proposes that net gain be understood in terms of three, interconnected measures of 'gain' and that a strategic approach is required in order to operationalise 'gain'. For the sake of completeness, we make concluding remarks on potential opportunities to translate these conceptual ideas into policy and practice.

There are two important opportunities, in the immediate term, to progress a re-framed 'net gain' model for the Yarra Birrarung:

- The Yarra Strategic Plan
- Birrarung Council's advice to the Minister and broader advocacy

The Yarra Strategic Plan

At the time of writing the Yarra Strategic Plan (YSP) is still in draft form. The following comments are based on the relevant provisions of the Act and content of the draft YSP. The YSP must be prepared with regard to principles including the environmental 'net gain' principle. As indicated in this report, the tenor of the Act – and by extension the YSP – concerns trajectories of long-term improvement best understood in terms of landscape restoration or recovery.

The machinery of the YSP includes the Community Vision, objectives, enumerated content, statutory cooperation of public agencies, public reporting, imperatives for public participation, and performance accountability and management. Target-setting is a likely part of this machinery. This machinery suits a landscape restoration and recovery approach. These arrangements align, at a general level, with key principles under national and international restoration standards.

Taking a restorative approach to landscape management in Victoria and in Melbourne is not especially new. The Healthy Waterways Strategy aims to take this approach. Earlier conservation planning took this general approach and developed detailed strategic and targeted measures.[136] Regional catchment strategies are intended to enable a restorative approach. Thus there is earlier 'scaffolding' to build on. What is different in the approach to the YSP considered in this report is:

- building restoration ecology science into that 'scaffolding';
- building the 'scaffolding' for action and planning specifically to the Yarra Birrarung; and in so doing,
- building the 'scaffolding' for the cultural landscape.

The first YSP is a 'stepping stone' toward long-term outcomes. The opportunity should be taken in the first YSP period to build the tools and machinery of solid, compelling and inspiring corridor planning, alongside material progress toward performance objectives. The

[136] See eg PPWCMA *Port Philip and Westernport Native Vegetation Plan* (2006), https://www.ppwcma.vic.gov.au/Resources/PublicationDocuments/6/Port%20Phillip%20and%20Westernport%20Native%20Vegetation%20Plan_web.pdf

opportunity should, be taken to 'lay the groundwork' as well as continue actual progress on restoration and recovery. 'Groundwork' in this context can include, for example, setting programs and processes for design of targets, outcomes sought, localised planning, agreement-making, and so on.

Birrarung Council advice and advocacy

The Birrarung Council may wish to progress its own work on the 'net gain' question in order to inform its work going forward. Developing thinking around 'net gain' at the conceptual level or at the applied or practical level would likely be useful in terms of informing engagement with Responsible Public Entities, Ministers, particular programs, policies or actions. This report proposes addressing 'net gain' in terms of certain themes and theories of change. It is open to the Council to determine whether they seek to adopt, amend or translate any or all of the thinking contained in this report into a statement or advice, and subsequently whether or how the Council chooses to use its contents or ideas in influencing decision-making or outcomes.

1.9.2 Potential tools for framing or enabling 'net gain'

The approach to 'net gain' proposed in this report could be used to inform further work on policy or technical instruments which could guide any future implementation.

Restoration Principles and Standards for the Yarra Birrarung?

National and international guidance on ecological restoration practice are important in framing environmental change and ambition-setting. They are authoritative and the product of broad collaboration, especially among scientists and practitioners, over an extended period of time. These types of instrument provide guidance at scale.

Guidance could be prepared at the specific geographic scale of the Yarra Birrarung.[137] National and international guidance can provide a template to do so.

Alongside the iterations of 'restoration principles and standards' the Society for Ecological Restoration International has previously produced detailed *Guidelines for Developing and Managing Ecological Restoration Projects*.[138] This latter guidance traverses the planning and delivery cycle, from concept planning to post-implementation tasks.

Methodologies for reference models and target-setting.

As set out in this report, the preparation of reference models, as key devices in restoration planning and practice, is in effect a form of long-term target-setting for any specific landscape and/or project. Medium-term target and objective setting underpin strategic planning based on this approach.

Target setting (for example, a reference model or interim targets) is equally as important as building consensus around a *process* for producing those outcomes. Agreed methodologies for constructing a reference model will also be important. These processes will be informed by scientific and cultural knowledge, restoration planning processes, and various actors (for

[137] Compare Chenoweth EPLA and Bushland Restoration Services *South East Queensland Ecological Restoration Framework: Guideline* (2012), http://www.seqcatchments.org/seq-ecological-restoration-framework
[138] SERI *Guidelines for Developing and Managing Ecological Restoration Projects* (2012), https://cdn.ymaws.com/www.ser.org/resource/resmgr/custompages/publications/ser_publications/Dev_and_Mng_Eco_Rest_Proj.pdf

example, agencies, community organisations, Traditional Owners, NGOs and landowners). Processes will be shaped by opportunities and constraints.

Technical and policy guidance on such methodologies exists and can be used as a basis for developing restoration strategies.[139] Methodologies can also borrow and learn from restoration examples elsewhere such as the National Cultural Flows Research Project.

Restoration models and practice typically have drawn heavily from case studies and lessons from projects and programs. There are abundant such examples. Very useful thinking and work has been undertaken locally and in relation to rivers and wetlands.[140]

Bearing in mind that reference models can be drawn from historical, as well as ecological, sources, the work undertaken in the Bulleen-Banyule Flats CVS is an important source for building reference models applying to the Birrarung cultural landscape.

Design of metrics and indicators aligned with restoration models and opportunities.
As noted in this report, certain methodologies serve to calculate forms of environmental improvement. Foremost among these in Victoria is the 'change in suitable habitat' tool devised by DELWP. Other representations of ecological properties or functions include habitat condition and connectivity. Such measures and indicia sit squarely within the ecosystem services and 'natural capital' modelling of the natural environment.

Cultural attributes which reflect Aboriginal values can be incorporated within this type of conceptual and policy infrastructure. Alignment between ecosystem service models and the Yarra Birrarung cultural landscape is feasible. Much rests on Wurundjeri control and authority in that type of process.

If restoration ecology is to provide guidance, design of measures and indicia for the Yarra Birrarung will be derived from reference models, the formulation of localised 'recovery' plans), and/or organisational tasks. These types of actions would also lead interim target-setting.

For example, floodplain restoration across the Yarra Birrarung corridor could be devised as a series of projects, using eco-hydrological indicators (such as extent and duration of inundation, species and habitat diversity, water quality, and groundwater connectivity), and measures of community and landowner participation. The latter could include measurable tools for overcoming legal or regulatory barriers, such as use of conservation covenants or other agreements enabling flooding or citizen science projects gathering scientific information. Given the recovery purposes of such projects, measurable indicia of recovery could include increases in presence of regionally or locally endangered species (as an indicator of extinction 'credit') or presence of key species hypothesized but previously unobserved (as an indicator of ecological memory). Specific content of indicators should be guided by reference models and targets. They are then guided by intended, collaborative, well-informed strategies enabling recovery of the natural and cultural landscape.

[139] See eg Hanson et al *The Restoration Diagnostic: A Method for Developing Forest Landscape Restoration Strategies by Rapidly Assessing the Status of Key Success Factors* (World Resources Institute, 2015), https://www.wri.org/publication/restoration-diagnostic
[140] See eg Nature Glenelg Trust 'Publications', http://natureglenelg.org.au/ngt-resources/publications/

2. Review of Literature

2.1 Review of literature 1: ecological and sustainability sciences and the framing of development and resource use

In response to the Brief, this report outlines and takes account of relevant literature relevant to the 'net gain' concept. That literature is vast. It comprises peer-reviewed academic studies, official and semi-official reports, policy documents, technical guidance, and relevant legislation or regulations. In a report of this nature it is not possible to undertake a full and comprehensive survey of literature. The outline below is high-level but sufficient to inform this project.

This section lays out that literature in three parts. This first part corresponds broadly to quantitative methods and sciences. The common thread of much of this literature is theoretical, practical and policy alignment of ecological sciences with patterns and modalities of (capitalist) development and resource use. For example, these fields of research focus on and emphasize how development and resource use models, as articulated in conventional economics, urban planning or public administration, can better accommodate insights from ecological and natural sciences, such as biophysical limits, system interdependence or biological cycles.

We consider three fields of research associated with this approach, broadly relevant to informing the framing of environmental 'net gain':

- Ecological economics and environmental accounting
- Environmental offsets literature.
- Urban ecology and 'green cities' literatures.

2.1.1 Ecological economics and environmental accounting

Ecological economics is an interdisciplinary model of economic and ecological sciences. It approaches ecological systems in the manner of stocks and flows of resources, while integrating ecological relationships and cycles into economic thinking.[141] According to ecological economics:

> … human economic activity is bound by absolute limits. These limits are not entirely fixed, however, since they are co-determined by: (1) (fixed) 'planetary boundaries' … and (2) (dynamic) social factors, such as values, institutions etc. The economy is viewed as a sub-system embedded in the larger systems of society and the biosphere.[142]

Given its interdisciplinary character, across biophysical and social sciences, ecological economics has been referred to as the 'science of sustainability'.[143] This is a fair representation, to the extent of its interrogation of the integrated ('triple bottom line') focus of sustainability and 'ecologically sustainable development'.

[141] Costanza 'What is ecological economics?' (1989) 1 *Ecological Economics* 1
[142] Bartkowski 'Ecological economics' (2016), https://www.exploring-economics.org/en/orientation/ecological-economics/ viewed 13 September 2020
[143] Faber et al 'Homo oeconomicus and homo politicus in ecological economics' (2002) 40 *Ecological Economics* 323

In a manner broadly consistent with neoclassical economics, ecological economics includes the conceptual separation of human well-being and the natural world, accompanied by the anthropocentric fulfilment of the former by the benefits of the latter. The value of nature lies in measurable, accountable qualities ecosystems provided to human society.[144] These qualities may or may not have market expression (as formal commodities). Ecological economics gives rise to key concepts such as 'ecosystem services', 'ecosystem goods' or 'assets', and the paradigmatic framework of 'natural capital' (or the global 'stock of natural assets'[145]). Generally, the human benefits derived from ecosystems are organised into 'provisioning services' (such as food, water, material, etc), 'regulating services' (such climate regulation, nutrient cycling, biological reproduction, etc) and 'cultural services' (such as recreation, spiritual, education or heritage benefits).[146] Tangible and intangible characteristics distinguish ecosystem 'goods' from beneficial 'services'.

The ascribing of value to ecosystems functions and benefits is founded on elaborated forms of economic 'valuation', supported by accounting techniques and formulae for imputing human welfare outcomes from ecological processes and natural features.[147]

Where valuation of nature according to these economic and accounting methods is factored into policy- and decision-making, quantification of the value and wealth associated with the functioning of natural systems can be profound.[148]

The importance of ecological economics and environmental accounting to concepts of 'net gain' is the extent to which they provide readily accessible tools for understanding nature and ecosystems in economic terms. This is language well-understood by decision-makers, policy-makers and indeed the general public. It is significant to making natural systems accessible in technocratic and popular terms.

The project of 'making nature visible' in economic terms is central to these approaches.[149] Deference of economics to ecological models, such as theoretical accommodation of complex natural interdependencies and system crises (for example, ecosystem collapse), is conceivable. However, the prevailing intention and set of assumptions is that nature provides benefits and values to human societies and these are to be accounted for. The method of doing so has been described as a 'three-tiered' approach, requiring techniques for *recognition* of those values (understanding the natural systems and their benefits), *demonstration* of those values (for example through valuation techniques), and *'capturing'* values (for instance, in price signals or incentive systems).[150]

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[144] See generally Millenium Ecosystem Assessment *Ecosystems and Human Well-Being: A Framework for Assessment* (2003), 53-59
[145] World Forum on Natural Capital 'What is natural capital?', https://naturalcapitalforum.com/about/
[146] Millenium Ecosystem Assessment *Ecosystems and Human Well-Being: A Framework for Assessment* (2003), 56-59
[147] See generally Millenium Ecosystem Assessment *Ecosystems and Human Well-Being: A Framework for Assessment* (2003), Ch 6
[148] In 1997, Costanza et al estimated the value of a bundle of ecosystems services, calculated globally, to be on average around US$33 trillion, or nearly twice the calculated value of global GDP: Costanza et al 'The value of the world's ecosystem services and natural capital' (1997) 387 *Nature* 253
[149] TEEB *The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature – A Synthesis of the Approach, Conclusions and Recommendations of TEEB* (2010), http://www.teebweb.org/wp-content/uploads/Study%20and%20Reports/Reports/Synthesis%20report/TEEB%20Synthesis%20Report%202010.pdf
[150] Ibid, Ch 2

Ways of accounting for nature in economic terms

A variety of influential platforms have emerged in recent decades setting out frameworks and detailed techniques for environmental-accounting of natural systems. For example:

- The UN Millennium Ecosystem Assessment,[151] which was a major collaborative scientific assessment of global ecosystem conditions and trends, undertaken with reference to the 'ecosystem services' paradigm.
- The UN System of Environmental Economic Accounting, which is the endorsed international standard for environmental-accounting adopted by the UN Statistical Commission.[152] The SEEA platform is influential on environmental-accounting systems globally, as well key measures for environmental governance within the international domain, such as UN Sustainable Development Goals.
- EU 'natural capital accounting', building on the SEEA model, establishes a range of environmental valuation tools in support of European environmental policies,[153] including 'experimental' (innovative accounting models) accounts in certain sectors, such as biodiversity (indicator species) and marine systems.[154]
- Specific biodiversity and 'natural capital' approaches can be found in initiatives such as The Economics of Ecosystems and Biodiversity program,[155] now auspiced by the UN Environment Program.
- Environmental accounts and ecological-economics have emerged as an important device for supplementing, or even modifying, conventional economic measures, such as GDP.
- Environmental accounting has become increasingly influential on 'state of the environment' reporting in Australia.[156]

The influence of ecological economics and accounting

The key ecological-economic paradigm of 'ecosystem services' has been described as 'probably the most important trend in conservation science at the moment…'[157] Concepts such as 'natural capital' and 'ecosystem services' now exert immense influence on public policy and on national and international institutions.

As noted elsewhere in this report, the influence of ecological economics is heavily embedded in current biodiversity policy. Concepts and methods of ecological economics and accounting extensively underpin biodiversity offsetting schemes and 'transactional' frameworks for managing and balancing 'trade-offs' of harms and improvements to natural systems. In both conservation policy generally and in offsetting arrangements as a policy tool, the ecosystem

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[151] See 'Guide to the Millenium Ecosystem Assessment Report', https://www.millenniumassessment.org/en/index.html

[152] UN Statistical Commission 'System of Environmental Economic Accounting', https://seea.un.org/content/about-seea

[153] European Commission 'Natural capital accounting', https://ec.europa.eu/environment/nature/capital_accounting/index_en.htm

[154] See eg King et al Experimental Species Accounts for the EU (UN Environmental World Conservation Monitoring Centre and European Environment Agency, 2019), https://ec.europa.eu/environment/nature/capital_accounting/pdf/Experimental%20species%20(bird)%20accounts%20for%20Europe.pdf

[155] See 'The Economics of Ecosystems and Biodiversity', http://teebweb.org/

[156] See Commissioner for Environmental Sustainability Framework for the 2018 State of the Environment report: State and Benefit (2015), https://www.ces.vic.gov.au/sites/default/files/publication-documents/Framework%20for%20the%202018%20State%20of%20the%20Environment%20report.pdf

[157] Douglas McCauley 'Selling out on nature' (2006) 443 *Nature* 27

services model informs techniques of valuing aspects of nature and the overall system of measuring those values. For example, biodiversity offsetting typically sets up a form of market in ecosystem services, in which detriment and benefit to biodiversity (such as expressed in habitat condition and extent) is quantified in 'scoring' systems and 'credits' representative of ecological values and which can then be monetised or expressed in formal commodities. Environmental 'loss' and 'gain' can be attached to human impacts on specific ecosystem goods and services, which can occur in relation to a specific 'service' or even in terms of complex 'bundled' ecosystem services.[158] In this way, ecological sciences inform economic models and transactions. Nature is made amenable to the market economy. Pricing signals are at least somewhat reflective of ecological harms and benefits and 'externalities' are reflected in the 'internalisation' of environmental costs and benefits in decision-making. That is also seen as a hallmark of ecological sustainability.

As the reliance of biodiversity policy on ecosystem services models would suggest,[159] a key driver of integration of ecological economics and environmental accounting into conservation policy and practice is controlling, framing and guiding the distribution and allocation of resources. For government this includes the rationing of public investment. Current biodiversity policy focuses specifically on the targeting of public financing (and to some degree private funds) to conservation priorities concerning threatened species management and habitat improvement. Conservation science and modelling here informs allocation of investment via the conceptual framework of priority ecological 'assets'.

As the literature on 'green cities' and 'urban science' also suggests,[160] ecological-economic models have assumed an important and powerful role in the science-policy link. Considerations of maintaining and building 'natural capital' in cities, or accounting for ecosystem services in urban design, has become an important touchstone in policy or project decisions. The proliferation of environmental 'decision support tools' in assessing specific actions, policies, programs, or projects and their environmental impacts and/or benefits rely extensively on concepts and methods with provenance in ecological economics and environmental accounting.

The nature of the economic measure of nature: recognising environmental values and standardising and controlling them

The relative success of ecological economics and its derivative ideas can be calculated not only in its influence on policy agenda but in the sophistication of its reappraisal of economics. The latter includes its responsiveness to ecological concepts and science, such as acceptance of ecological limits to growth, inherent ecological complexity and non-fungible (exchangeable) values or benefits.

At a more fundamental level, ecological economics breaks with certain basic conventions of 'mainstream' neoclassical economics, such as assumptions about human behaviour and the human condition. In its willingness to accept and adopt aspects of, for example, interdependence of human and natural systems in ecological thinking, this body of thought presents a challenge to the mode of the 'economic person' – *homo economicus* – that underpins mainstream economics. This is the model of the economic actor as motivated by individualistic welfare ('utility') maximisation, is perfectly rationalistic, and for whom

[158] See [1.6] above
[159] See [1.4] above
[160] See [2.1.4] below

environmental conditions are essentially 'external' to decision-making. The basic tension between this model of the economic person and a reformed economic actor under ecological economics is incorporated into the set of interests exemplified in that actor 'common good', or 'public', interests. The common good character of human benefits derived from ecological resources means the economic actor has an intrinsic interest in the integrity of nature. This field of interests extends beyond the sole *self*-interest of *homo economicus*. Ultimately, ecological economics seeks to measure, in the terms of economic value, the 'common' benefits and values of natural systems. Hence, the ambition of this ecological-economic actor is not so much self-interest as sustainability.[161]

Ecological economics can account for the human well-being benefits provided by nature (which can be associated with ideas of environmental 'gain') but which cannot be directly commodified – that is, directly subject to market exchange. At the same time, of course, this discipline does possess the techniques to *commodify* nature: for example, by 'packaging' up 'common good' aspects of nature and ecosystems (such as biodiversity, water purification, or pollination) and 'unbundling' them through environmental markets. These are policy-generated schemes for trading in 'ecosystem services'.[162] Biodiversity offsets are a form of this 'unbundled' environmental commodity, where the harm and recovery of habitat integrity is for sale.

2.1.2 Environmental offsets

The literature on environmental offsets is a sub-set of literature on conservation policy and the ecological sciences informing it. It operates at intersections between conservation and economic development. The idea of 'offsetting' harm or impairment caused to natural features resulting from development or resource use has its origins in the 1980s, specifically as a policy device to permit harms to US wetlands within the confines of Federal environmental laws. Since then this 'tool' has become widespread. It is especially relevant to interrogation of concepts of environmental 'net gain' because, firstly, offsetting techniques are often part of the authorising and normalising environment for development and resource use decision-making, and, secondly, the offsetting device is held to be instrumental to authorised actions intended to achieve cumulative improvements ('net gain') to the environment.

Offsets as a policy device

Biodiversity offsets are one form of a model of compensatory action intended to address adverse environmental impacts. The leading collaboration in this field, the Business and Biodiversity Offsets Programme (BBOP), provides a leading definition:[163]

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[161] See Faber et al 'Homo oeconomicus and homo policitus in Ecological Economics' (2002) 40 *Ecological Economics* 323; Urbina and Ruiz-Villaverde 'A critical review of Homo Economicus from five approaches' (2019) 78 *America Journal of Economics and Sociology* 1 63

[162] Strictly speaking, such schemes set up legal and policy arrangements for recognition of consideration in the provision of environmental (public good) benefits. Obligations to undertake conservation actions consistent with those benefits can be exchanged for value (i.e. money) under market arrangements set up for the purpose. Those transactions may occur on condition of environmental harms legally sanctioned elsewhere (offsets) or by way of direct purchase by government of private actors (eg conservation 'reverse auctions').

[163] BBOP The BBOP Principles on Biodiversity Offsets, https://www.forest-trends.org/wp-content/uploads/2018/10/The-BBOP-Principles_20181023.pdf; see also BBOP Standard on Biodiversity offsets (2012), https://www.forest-trends.org/bbop_pubs/standard-on-biodiversity-offsets/, and other material available from their platform: https://www.forest-trends.org/bbop/.

> Biodiversity offsets are measurable conservation outcomes resulting from actions designed to compensate for significant residual adverse biodiversity impacts arising from project development after appropriate prevention and mitigation measures have been taken. The goal of biodiversity offsets is to achieve no net loss and preferably a net gain of biodiversity on the ground with respect to species composition, habitat structure, ecosystem function and people's use and cultural values associated with biodiversity.

As this definition indicates, offset measures set up a form of transactional relationship between activities causing environmental harm, loss or impairment and countervailing actions intended to compensate for those adverse outcomes. That 'transaction' may be relatively direct in character, such as where a farmer agrees to protect and revegetate habitat on land in order to counteract land-clearing nearby, or it may be part of elaborate emerging and mediated market transactions where sophisticated 'credits' and offset 'banks', representing biodiversity values, are traded through registers and other institutional devices. The transaction is, in essence, a measurable and corresponding exchange between impact and conservation (or restorative) action.

Biodiversity offsets are a 'family' of policy devices,[164] typically employed to mitigate or counteract the effects of development, land or resource use, and thereby tying development to conservation performance (and vice versa). Effectively, they are also a legitimation device for development impacts on biodiversity.[165]

The 'net gain' paradigm is embedded in environmental offsetting as a policy goal.[166] It signifies an overall beneficial conservation (environmental) achievement, as compared to a 'neutral' outcome of 'no net loss'.

Offsets or analogous schemes have proliferated globally. In 2010, just over 60 offsets programs were identified world-wide.[167] By 2019, the IUCN could record nearly 13,000 offsets projects in 37 countries covering greater than 150,000 km2.[168] Offsets schemes relevant to the Yarra River corridor are considered in Appendix 2.

The theoretical and policy literature on offsets identifies certain key features to this device:

- Offsets are residual. Their requirement or relevance is triggered subsequent to avoidance and/or minimisation of adverse impacts to landscapes or seascapes.
- The goal for offsetting (no net loss or net gain) needs to be accounted for in the context of appropriate policy goals and environmental baselines. These objectives may contribute to wider biodiversity or conservation goals (for example, regional, national or international conservation priorities and obligations).
- There are limits to the use of biodiversity offsetting. There are thresholds of risk beyond which offsetting is not appropriate.[169] In particular, biodiversity matters or values that are irreplaceable or vulnerable should not be susceptible to the application

[164] Bull et al 'Biodiversity offsets in theory and practice' (2013) 47 Oryx 3 369, 370
[165] Lindsay *Reforming native vegetation offset rules in Victoria* (2013), https://www.envirojustice.org.au/sites/default/files/files/Submissions%20and%20reports/native_vegetation_offsets_report.pdf; Lindsay 'Environmental loss and environmental excuses: native vegetation clearing rules in Victoria' (2014) *Australian Environment Review* 165
[166] Also referred to as a 'target': see IUCN *Policy on Biodiversity Offsets* WCC-2016-Res-059-En, [11]
[167] See Maron et al 'Faustian bargain: restoration realities in the context of biodiversity offsets policies' (2012) 155 Biological Conservation 141, 142
[168] GIBOP *Global Inventory of Biodiversity Offsets Policies* (IUCN, 2019), https://portals.iucn.org/offsetpolicy/
[169] See BBOP *Limits to what can be offset* (2012), https://www.forest-trends.org/wp-content/uploads/imported/BBOP_Resource_Paper_Limits_20_Mar_2012_Final_Rev.pdf

or availability of offsetting. Social and cultural factors based on ecology can be determinative of limits to offset use. Non-feasibility of offsetting arrangements can be a threshold to their use.

- Robust schemes for measuring the 'transaction' are required. Schemes for establishing the 'currency' of offset transactions are essential. These may be in relatively simple terms such as geographic area, but typically complex quantifiable metrics representing biodiversity (or other) values are developed for this purpose. Quantifiable metrics may reflect individual biodiversity values (such as habitat) or multiple values in sophisticated, integrated measurement schemes.
- Compensatory actions ('gain') must be additional to obligations or intentions already in place as a matter of law, policy, agreement or other (for example, financing) arrangement. This principle is referred to as 'additionality. It is intended to ensure that any particular offsetting action leads to environmental improvement.
- Uncertainties and appropriate timeframes need to be accounted for in any offset arrangement. Offsets are in part based upon a future or ongoing promise (to deliver a conservation benefit) and hence uncertainty is inherent in the exercise. The benefit may not be delivered, for whatever reason.
- Sufficiently effective monitoring, reporting and governance both for the offset transaction and 'delivery' of the offset need to be in place. Without these components, offsetting cannot be approached with any degree of confidence, reliability or transparency.

The arguable benefit and value of environmental offsets as a policy device is that they expressly connect environmental harm or loss to actions designed for environmental improvement, in a manner designed to reflect a scientific and reasoned basis to this connection. This nexus is often legally binding. That is usually the case in Australia.

The critique of environmental offsetting

Notwithstanding the popularity of offsets as an environmental conservation device, they have been heavily criticised, both in terms of conceptual shortcomings and empirical outcomes. Conceptually, key criticisms of biodiversity offsetting specifically include:

- The problem of commensurability (equivalence) between biodiversity lost through development actions and 'gains' achieved though conservation actions comprising an offset.
- The problem of reflecting the full complexity or diversity of natural systems in measures (metrics) functioning as proxies for values in those systems.
- The problem of assessment by way of 'counterfactual' scenarios, whereby 'gain' assumed to occur includes substantially a benefit from 'averted' or 'avoided' losses.[170]
- Problems of compliance or governance of offset arrangements
- Problems in unrealistic restoration outcomes advanced in 'no net loss' or similar objectives.[171]

[170] See Maron et al 'Locking in loss: baselines of decline in Australian biodiversity offset policies' (2015) 192 *Biological Conservation* 504

[171] Curran et al 'Is there any empirical support for biodiversity offset policy?' (2014) 24 *Ecological Applications* 4 617

Empirically, accumulating evidence from offset schemes indicates success of these arrangements is at best uneven, unclear, or, more likely, not achieved in the majority of cases.[172] Features of biodiversity offsets schemes appearing to contribute to successful outcomes include, for example, use of high multipliers, schemes concerning wetlands rather than other ecosystems, robust application of the avoidance hierarchy, ecosystem values can be appropriately measured, a sound scientific basis demonstrating restoration feasibility, 'averted loss' models are avoided, and schemes are inapplicable to old-growth or late-successional (mature ecosystem) contexts.[173]

Cutting across both conceptual and empirical critique of offsets, the transactional character of any scheme aiming for a 'net' outcome relies on constructing reference scenarios, specifically reference models that are amenable to transaction and accounting (such as codified forms of 'gain' that can be included in systems of 'credit' and exchange). These reference models lend themselves in principle to simplification and standardisation of natural qualities, such as population numbers of a species as a proxy for an ecological system. These approaches are particularly acute in biodiversity offsetting schemes and can coincide with reference scenarios that assume biodiversity decline or loss. Additionally, in practice there can be disconnect or disjuncture between reference scenarios relevant to assessing specific impacts and reference conditions at scale or jurisdictional level.[174]

There is a stark contrast to how reference models are viewed under literature associated with offsetting and understanding of reference models in ecological restoration literature.

Target-based, 'jurisdictional' compensation as an alternative to offsetting

An emerging variation on the biodiversity offsetting model is a 'target-based approach for ecological compensation.'[175] This is an approach that may be particularly relevant to application of the 'net gain' concept under the Yarra Birrarung Act, given the performance-based character of river planning and likely inclusion of target-setting under that strategic planning.

The central design feature of this approach is detachment of restorative practice or programs for ecological (biodiversity) compensation from project-level environmental impacts. By contrast, the approach proposes express and systemic integration of 'compensatory' – that is, restorative – measures into 'jurisdictional' biodiversity conservation policy and strategy. This integration would occur primarily through target-setting for conservation outcomes (and potentially aligned outcomes, such as cultural or social outcomes) attached to a given 'jurisdiction'. 'Jurisdiction' here refers to set decision- or policy-making space, such as

[172] See eg Maron et al 'Faustian bargains'; Curran et al 'Is there any empirical support for biodiversity offset policy?' (2014) 24 *Ecological Applications* 4 617; Gibbons et al 'Outcomes from 10 years of biodiversity offsetting' (2018) 28 *Global Change Biology* 2 e643; zu Ermgassen et al 'The ecological outcomes of biodiversity offsets under "no net loss" policies: a global review' (2019) 12 Conservation Letters 6 e12664; Lindenmayer et al 'The anatomy of a failed offset' (2017) 210 Biological Conservation 286

[173] See eg zu Ermgassen et al 'The ecological outcomes of biodiversity offsets under "no net loss" policies: a global review' (2019) 12 *Conservation Letters* e12664; Maron et al 'Faustian bargains? Restoration realities in the context of biodiversity offset policies' (2012) 155 *Biological Conservation* 141; Gibbons et al 'Outcomes from 10 years of biodiversity offsetting' (2017) *Global Change Biology*, 00:1–12. https://doi.org/10.1111/gcb.13977; Gibbons et al 'A loss-gain calculator for biodiversity offsets and the circumstances in which no net loss is feasible' (2015) 9 *Conservation Letters* 4 252

[174] Maron et al 'The many meanings of no net loss in environmental policy' (2018) *Nature Sustainability* 1 19

[175] Simmonds et al 'Moving from biodiversity offsets to a target-based approach for ecological compensation' (2020) 13 Conservation Letters e12695

regional or even national governance context. For present purposes, the *Yarra Strategic Plan Area* could equate to a relevant 'jurisdiction'.

A distinguishable feature of this 'jurisdictional' model for ecological compensation is that the focus of such arrangements strategically shifts from the *source* of ecological harm or damage (such as development), including the environmental management of that source, to the *object* of 'compensation' or, rather, of 'gain' reflected in biodiversity conservation outcomes set under targets. The intended purpose of this strategic shift is for the structured response of conservation actions, resulting from specific harms, to focus on conservation policy and strategy rather than *ad hoc* (project-specific) assessments and calculations. The response focuses on assessment of conservation needs, as set by targets and policy, rather than assessment of environmental harm or loss.

Importantly, the jurisdictional model maintains a nexus between environmental harm and benefit (referred to as 'compensation'). To this extent, the model does represent a form of 'transactional' approach to environmental management but viewed through a far more strategic, rather than case-specific,[176] conservation lens. Similarly, considerations for 'compensation' are not triggered until issues of avoidance, mitigation and rehabilitation are accounted for, as with conventional offsetting. However, it is arguable that the focus on outcomes and conservations targets under the 'jurisdictional' model also attaches greater scope for alignment of project and development design, or other avoidance measures, with intended conservation outcomes or targets – strategic objectives for a particular 'jurisdiction', including targets, are known up-front and can inform project design. In this manner there are affinities between this approach and development models such as 'biodiversity sensitive urban design' which is referred to below.

'Net gain' example 2: The United Kingdom as a case study for managing net-gain and restoration: what does another jurisdiction tell us?

In 2018, the United Kingdom government amended overarching land-use (town and country) planning policy to require all development and infrastructure approvals impacting on biodiversity to deliver a 'net gain' for biodiversity, either on-site or elsewhere.[177] The 25-year UK Environment Plan committed to embed an 'environmental net gain' principle in the development planning system.

A consultation on whether net gain should be mandatory ran from December 2018 to February 2019. Details of the policy were then set out in the government's response to the consultation.

To this point, planning policy in the UK required a 'no net loss' outcome from development impacts and 'good practice' guidance had established voluntary industry standards for a 'net

[176] The *ad hoc* or case by case nature of offsetting criticised in this model does, in principle, extend to 'ecological compensation' arising from harmful actions approved at scale (such as development programs or policies approved through strategic assessment processes). What is referred to 'project-specific assessment' in this paper equally applies to assessments and decisions that operate at larger scales. The common link is to what the authors refer to as the 'counter-factual' methods used in assessment of losses.

[177] See generally Wentworth *Net Gain* (Parliamentary Office of Science and Technology, POST Brief 34, 2019), https://researchbriefings.files.parliament.uk/documents/POST-PB-0034/POST-PB-0034.pdf

gain' approach.[178] International guidance has taken the approach that offsetting should lead to a 'no net loss' outcome but 'net gain' is preferable. Weaknesses in the voluntary 'net gain' scheme had been earlier documented and biodiversity planning approaches were viewed as not contending with continued decline in UK biodiversity.[179]

Subsequently, the UK government has introduced legislation into the UK Parliament to legislate for this environmental 'net gain' standard through the Environment Bill 2019-21. The biodiversity 'net gain' provision is to be introduced by way of deemed condition on all planning permissions (other than where exempted) for developments in the UK

The 'net gain' approach intends for development to leave the natural environment in a measurably better state than before a specific plan or project is undertaken. The underlying concept is to address market failures and reduce the pressure of development on biodiversity. As a transactional model the developer has to protect existing areas of value and/or ensure any lost or degraded values are more than compensated for by enhancing existing or creating new areas to benefit nature and people.

A system of biodiversity quantification (metrics) has been developed based on measures for habitat 'distinctiveness', condition, strategic significance and connectivity.[180] These measures would not be unfamiliar in the Victorian setting, other than perhaps distinctiveness which is a measure based on different ecosystem classifications (forest, moorland, etc).

The quantum of 'gain' to be generated by development actions under this scheme, based on these metrics, is to be 10%, which is to say development leading to adverse environmental impacts must contribute at least 10% greater biodiversity 'credit' or 'score' than lost.

This outcome can be achieved on the site affected or elsewhere and, as such, the 'net gain' outcome can be aligned with or contribute to biodiversity priorities under broader strategies and plans. For example, biodiversity net gain arising from development can be managed in a manner by which it aligns with 'local nature recovery strategies' that are to be prepared and implemented throughout England. Each would include a statement of biodiversity priorities for the area covered by the strategy and a local habitat map that identifies opportunities for recovering or enhancing biodiversity.[181] The proposed legislation stops short of how local areas should arrive at appropriate conservation objectives at these landscape scales.

The 'net gain' mandate is part of a wider legal and policy package of measures including:

- the establishment of a Nature Recovery Network

[178] Ibid
[179] WSP Parson Brinkerhoff *Biodiversity Net Gain: A New Role for Infrastructure and Development in Improving Britain's Wildlife* (2016)
[180] Biodiversity in Planning 'Biodiversity net gain: future developments must improve wildlife habitats', https://www.biodiversityinplanning.org/news/bd-net-gain/
[181] *Environment Bill 2019-2021*, cl 97

- Local Nature Recovery Strategies drawn up at the local authority level
- Green Infrastructure Standards, and
- the provision of Conservation Covenants as a new statutory mechanism to legally secure protection of offset sites
- a general duty to conserve and enhance biodiversity

There is little guidance as to what the NRN might involve. Advice from the UK's statutory nature agency suggests the 'network' is more than strictly 'ecological', in the sense perhaps of a protected areas network, and reflects the need for a socio-ecological approach.[182]

The UK reform proposed for England lends itself to certain conclusions:

- The biodiversity 'net gain' provisions generally reproduce the intention for 'net gain' to function as a distinctive objective, consequential to (harmful) impacts from development. In this regard, 'net gain' will function essentially as a compensatory device, arising from development transactions. Development will drive biodiversity management.
- The contributions of the framework to ecological outcomes will be potentially diverse, based on the various metrics or measures of 'gain', but nevertheless confined to those metrics.
- Biodiversity 'net gain' is intended to align with wider biodiversity mechanisms and 'tools', potentially at the ecosystem scale, such as through broader 'recovery strategies' and 'nature recovery network'. The detail of this alignment is not clear, although its precise dynamics and unfolding may depend on the guidance of the principal, independent statutory agency (Nature England).

2.1.4 Urban ecological sciences and 'green cities'

The next source of literature relevant to environmental 'net gain' for the Yarra Birrarung is an extensive literature broadly encompassing urban ecology (including urban waterways) and 'green' or ecologically 'sensitive' cities.

[182] Nature England *Nature Networks Evidence Handbook* (2020), http://publications.naturalengland.org.uk/publication/6105140258144256, [3], [6]:

> To make a nature network, in contrast to an ecological network, we need to involve people from the earliest stages in planning and design, to create an overarching vision for the network, taking into account their needs and the services that a landscape provides to society…When implementing the plans for a nature network there are various key practical aspects that need to be considered: working within the planning system, working with landowners and farmers and working with the natural processes that operate within a landscape.

Urban ecology

Cities and urban spaces have been viewed historically as separate from nature and ecological systems. This can be expressed in a 'city-bush' or 'urban-rural' divide or notions that 'wilderness' is elsewhere. As empirically difficult as this proposition is to sustain, extensive literature on urban ecology and urban landscapes not only demolishes the myth factually and scientifically but establishes more effective and robust ways in which to frame urban ecology or 'nature in cities'. Cities not only influence nature but they *are* ecological systems and depend on complex social and physical interactions with the biosphere.[183] The principal thread through this diverse body of literature concerns application of ecological sciences to the social phenomena of cities and urban spaces and development of ecological thinking as a consequence. Ecological theories, paradigms and hypotheses are widely applicable to urban settings and they provide valuable sources of knowledge in relation to conservation, restoration or adaptation of the environment.[184] Biodiversity and ecological assessments are undertaken in urban areas, including Melbourne, often in response to development or land-use changes but also for proactive landscape assessment.[185] Study and analysis of the urban environment has increasingly sought to account for, if not integrate, natural and biophysical sciences on the one hand and social science on the other hand. In other words there is emergence of a socio-ecological science of the city. For example, the geography of urban tree canopy cover (urban forest) is considered in terms of its contribution to mitigation of climate-related 'heat island effects' as well as social distribution of benefits and burdens of this ecological feature.[186] Such interdisciplinary approaches to urban ecology is often couched in terms of the distribution and character of 'ecosystem' or 'nature-based' 'goods and services'.

The urban-ecology scientific literature is particularly important in terms of setting out the often distinctive or unique nature of ecological systems in cities, as well as peri-urban areas.[187] These types of insights may be crucial especially in application of conservation and restoration sciences to specific geographies, such as in the formulation of reference conditions, baselines and other techniques essential to identifying and assessing performance regimes for environmental management. The distinct structuring of the Yarra Birrarung corridor into geographic 'reaches' is a case in point.
Examples of relevant innovations and insights from the literature include:

- the importance of cities as biodiversity 'hotspots',[188]
- cities present 'novel' ecosystems,[189]

[183] See Seto et al 'A global outlook on urbanisation' in Elmqvist et al (eds) *Urbanisation, Biodiversity and Ecosystem Services: Challenges and Opportunities: A Global Assessment* (Springer, 2013)
[184] Parris 'Existing ecological theory applies to urban environments' (2018) 14 Landscape and Ecological Engineering 201
[185] See eg Australian Research Centre for Urban Ecology *Biodiversity of Metropolitan Melbourne* (Report prepared for the Victorian Environment Assessment Council, 2009)
[186] See eg Special Issue on Forests and Sustainable Cities (2018) 69 Unasylva, https://nespurban.edu.au/wp-content/uploads/2019/01/Dobbsetal2018_Unasylva_FORESTSANDSUSTAINABLECITIES.pdf; Resilient Melbourne and The Nature Conservancy Living Melbourne: Our Metropolitan Urban Forest (2019), https://www.nature.org/content/dam/tnc/nature/en/documents/australia/2019LivingMelbourne_Strategy_online.pdf
[187] Kirsten Parris Ecology of Urban Environments (Wiley-Blackwell, 2016). Parris proposes that the ecological analysis of cities is sufficiently unique to warrant a new interdisciplinary approach, an 'urban science': Parris 'Do we need a new theory of urban ecology?' (2016) 47 *Bulletin of the Ecological Society* 4 28
[188] Ives et al 'Cities are hotspots for threatened species' (2016) 25 Global Ecology and Biogeography 117
[189] Liz Kimbrough 'Cities as novel ecosystems: adaptations to urban conditions'', PLOS Blog, 19 August 2016, https://theplosblog.plos.org/2016/08/novel-ecosystem-in-cities-adaptions-to-urban-conditions/

- ‘wild’ lands or ‘wilderness’ are relevant to and an important contributor to cities,[190]
- Small, disconnected patches of biodiversity, typical of urban areas, can have disproportionately important ecological value,[191]
- Urban forest strategies can be threatened by narrow revegetation strategies and behaviours.[192]

Urban streams

Of particular relevance to conservation policy and practice in the Yarra Birrarung corridor is the subset of urban-ecology literature dealing with streams, wetlands and aquatic environments. Consideration of the impacts and interactions of the urban landscape on waterways has been widely documented, specifically through programs of research in Melbourne. The significance of waterways on urban life (such as health, child development, and urban amenity and cooling) has also been widely studied. Reflection of those values now occurs in Victorian planning and water policy.

A prominent focus of the scientific literature on urban streams has been on key drivers in ecological degradation of streams and strategies for repair or recovery of those streams. The foremost driver is the connection of waterways to urbanising catchments, specifically directly-connected stormwater drainage systems. Other important drivers have been non-reticulated sewerage and land clearing in riparian zones. Conventional stormwater drainage is the predominant factor giving rise to ‘urban stream syndrome’, given its influence on complex degrading factors in stream ecology arising from high levels of imperviousness and surface runoff, low infiltration rates, dramatically changed hydrology, and distorted nutrient balances.[193]

Theoretical and practical work directed to solutions to this ‘urban stream syndrome’, with the focus on tackling stormwater sources of degradation, have progressively informed programs for stream protection and restoration. Practical programs to date appear to prioritise engineering outcomes, with uneven biodiversity achievements, alongside other, arguably more marginal efforts at behavioural change. Responses to degrading influences on urban streams, especially stormwater, have been a focus of major policy and planning responses, such as the Healthy Waterways Strategy, State Environment Protection Policy(SEPP) (Waters) and planning policy updates.

The degree to which this effort has influenced overall trajectories (or ‘health’) in urban streams is cause for perhaps guarded pessimism. Stormwater impacts on ecosystems are not reversing in any significant way, although efforts to tackle the problem are widespread. Of particular relevance to the question of environmental outcomes for the Yarra Birrarung is that only a very small part of the influencing catchment of the river falls within the statutory corridor (‘Yarra Strategic Plan Area’). Also of relevance to the ‘net gain’ model is emergence of forms of stormwater ‘offsetting’, intended to enable beneficial actions, via works, where

[190] McKinney et al ‘’The contribution of wild urban ecosystems to liveable cities’ (2018) 29 Urban Forestry and Urban Greening 334, https://nespurban.com/wp-content/uploads/2018/11/Editorial-Urban-wild-preprint.pdf
[191] Wintle et al ‘Global synthesis of conservation studies reveals the importance of small habitat patches for biodiversity’ (2019) 116 PNAS 3 909
[192] Lohr et al ‘Urban trees worldwide have low species and genetic diversity, posing high risks of tree loss as stresses from climate change increase’ (2016) 1108 Acta Hortic 263
[193] Walsh et al ‘The urban stream syndrome: current knowledge and the search for a cure’ (2005) 24 Journal of the North American Benthological Society 3 706

on-site stormwater controls are not possible.[194] Both conceptually and empirically, the achievement of overall stream ecology benefits from stormwater offset devices (for example, to contribute to an environmental 'net gain') appears problematic, especially as a result of the highly context-specific and distributed effects of stormwater on stream ecosystems.[195]

Environmentally 'sensitive' cities

Synthesis of science, engineering and policy in relation to urban ecosystems has given rise to a theoretical and policy space we might refer to as environmentally 'sensitive' cities. This term aims to traverse a body of literature concerned with thinking broadly directed to environmental sustainability and positive ecological outcomes integrated into urban design or development planning and practice. A wider range of relevant terms are used, such as 'water sensitive urban design', 'green cities', 'urban greening', 'green infrastructure' or 'natural infrastructure' and 'biodiversity sensitive urban design'. The intersections of science, policy and practice in these fields will give greater or lesser weight to human interventions into environmental processes and natural places, and vary those interventions in accordance with the priorities, predilections and methods of the particular paradigm at issue. For example, 'water sensitive urban design' includes interventions intended to extensively refit or reconstruct urban drainage systems in order to mimic certain (often discrete) natural processes, such as mitigating flow rates and enabling biodiversity outcomes through stormwater wetland construction or enabling infiltration through forms of distributed groundwater recharge. On the other hand, the intervention strategy may be much more expressly directed to *enabling* ecological processes in the context of dramatically changing (Anthropocene) environments,[196] which may require forms of 'soft engineering' as well as intentional withdrawal from active human engagement (for example, 're-wilding').

Key values of the 'environmentally sensitive city' literature are not only that it sets out comprehensively a field of knowledge integrating (a meeting point) ecological science, policy and practice but it does so at various scales and it provide a multitude of sometimes competing, sometimes complementary methods.

Literature that broadly identifies with concepts and models of 'green cities' has proliferated over more than a decade. Concepts of 'greening' cities and 'green infrastructure' are also closely associated with the 'green city' – which can be both a framing of urban design and policy and an objective. 'Green infrastructure' (or 'natural infrastructure'[197]) tends to adapt the content of ecological sciences and natural systems (among other fields) to the techniques and language of urban planning, economics and engineering,[198] with a view to dismantling

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[194] See eg Melbourne Water 'Stormwater offsets explained', https://www.melbournewater.com.au/building-and-works/developer-guides-and-resources/drainage-schemes-and-contribution-rates-2-0

[195] Commonwealth Parliament Environment and Communications Committee *Stormwater Management in Australia* (2015), [4.18]-[4.21], https://www.aph.gov.au/parliamentary_business/committees/senate/environment_and_communications/stormwater/report; Coker et al 'Alternatives to biodiversity offsets for mitigating the effect of urbanization on stream ecosystems' (2017) 32 *Conservation Biology* 4 789

[196] See eg Bowman et al 'Renewal ecology: conservation for the Anthropocene' (2017) 25 Restoration Ecology 674

[197] See generally eg WRI 'Natural Infrastructure', https://www.wri.org/tags/natural-infrastructure. Greening Australia *Investment in Natural Infrastructure to Offset the Environmental Impact of Future Development of Built Infrastructure* (2019), https://www.infrastructureaustralia.gov.au/sites/default/files/2019-06/Infrastructure_Australia_Consultancy_Report_Greening_Australia_Final.pdf

[198] See eg Chenoweth et al 'The interrelationship of green infrastructure and natural capital' (2018) 75 Land Use Policy 137;

the dichotomy of development and environment in those fields of thinking and practice.[199] It may also be associated with a certain utilitarian approach to nature in urban design and development, such as in advocacy for 'nature-based solutions' to urban issues.[200] Application of natural systems and process, via 'natural infrastructure', to resolution of urban infrastructure problems is increasingly widespread, in particular in relation to water supply, coastal impacts, and flood control.[201]

The 'green city' idea is a vehicle for the application and targeting of a wider range of ecological, social and other scientific work,[202] for example economics,[203] urban planning,[204] social sciences,[205] social psychology,[206] and aesthetics,[207] as well as natural sciences.[208] use, and mitigation and adaptation to climate change.[209] There is a strong environmental performance element to this approach, based broadly on action planning and accountability on that planning.

Specific models of urban design have evolved in support of the general 'green cities' and related agenda. Water-sensitive urban design (WSUD) is perhaps the best known of these approaches. It conceptually underpins somewhat nebulous terms such as 'liveability',[210] as

[199] The terms is used as a basis for policy reform for protection of Melbourne's western streams: EJA *A New Deal for the Rivers and Waterways of Melbourne's West* (2018), https://www.envirojustice.org.au/a-new-deal-for-the-rivers-and-waterways-of-melbournes-west/

[200] Eg IUCN 'Nature-based Solutions', https://www.iucn.org/theme/nature-based-solutions

[201] See eg NRDC 'Green infrastructure: how to manage water in a sustainable way', https://www.nrdc.org/stories/green-infrastructure-how-manage-water-sustainable-way; NOAA ''Natural infrastructure', https://coast.noaa.gov/states/fast-facts/natural-infrastructure.html#:~:text=Examples%20include%20mangroves%20and%20wetlands,way%20to%20protect%20coastal%20communities; Trust for Nature has previously put forward a proposal for a for nature-based solutions to enhance water quality outcomes in the Yarra system (Marnie Lassen, pers comm).

[202] The examples and citations below are extracted from *The Conversation*. That source provides both an illustrative sample of literature, based primarily on academic work, and a source that is relatively accessible. These examples are by no means exhaustive.

[203] Eg Herath 'Home prices tell us the value the public puts on green spaces' The Conversation, 2 March 2017, https://theconversation.com/home-prices-tell-us-the-value-the-public-puts-on-green-spaces-71872

[204] Eg Matthews et al 'Here's how green infrastructure can easily be added to the urban planning toolkit' The Conversation, 26 April 2016, https://theconversation.com/heres-how-green-infrastructure-can-easily-be-added-to-the-urban-planning-toolkit-57277

[205] Farahani and Maller 'How do we turn a drain into a valued green space? First, ask the residents' The Conversation, 8 November 2017, https://theconversation.com/how-do-we-turn-a-drain-into-valued-green-space-first-ask-the-residents-86226 Furlong et al 'How Melbourne's West was greened', The Conversation 16 October 2017, https://theconversation.com/how-melbournes-west-was-greened-84700

[206] Myers 'Biodiversity and our brains: how ecology and mental health go together in our cities' The Conversation, 2 January 2020, https://theconversation.com/biodiversity-and-our-brains-how-ecology-and-mental-health-go-together-in-our-cities-126760; Horwitz et al 'How urban bushland improves our health and why planners need to listen' The Conversation, 4 Mary 2017, https://theconversation.com/how-urban-bushland-improves-our-health-and-why-planners-need-to-listen-72876

[207] Lacey 'Bringing a "second nature" into our cities: wildness, art and biophilic design' The Conversation, 8 March 2018, https://theconversation.com/building-a-second-nature-into-our-cities-wildness-art-and-biophilic-design-88642

[208] Fisher and Trainham 'Is there room for nature in our cities?' The Conversation, 4 March 2013, https://theconversation.com/is-there-room-for-nature-in-our-cities-12145; Wintle and Bekessy 'The small patch of bush over your back fence might be a key to a species' survival' The Conversation, 13 December 2018, https://theconversation.com/the-small-patch-of-bush-over-your-back-fence-might-be-key-to-a-species-survival-108672

[209] EBRD *Green Cities Programme Methodology* (2016), https://www.ebrdgreencities.com/news-events-and-publications

[210] Johnstone et al *Liveability and the Water Sensitive City: Science-Policy Partnership for Water Sensitive Cities* (CRC for Water Sensitive Cities, 2012)

well as far more pragmatic outputs such as stormwater treatment works attached to urban development. It is effectively a form of application of the 'nature-based solution' or 'natural infrastructure' approach, often applied specifically to the stormwater problem,[211] although arguably it concerns a wider set of interventions in the hydrological cycle as its applies to cities.[212]

Interdisciplinary science partnership with urban policy- or decision-making now traverses other, albeit related, domains beyond water. A good example of this is the concept of 'biodiversity sensitive urban design' (BSUD) as a model and set of techniques for the integration of biodiversity conservation into urban development. The approach aims, in principle at least, to establish a mechanism of urban planning superseding the conventional treatment of nature in cities as a focus of 'protection' solely and encumbrance on property (and development) in law. In particular, the technique, in a manner similar to WSUD applications, looks for alignment and 'synergies' between commercial (especially 'grey') development objectives and biodiversity objectives and outcomes at the design stage.

As with all of these urban design and 'nature-based' techniques applied to development and urban landscape, issues of economics, the mobilisation of investment and resources, and 'asset' financing are prominent at the level of policy design and implementation. Devices such as WSUD and BSUD models are important and relevant to questions of landscape outcomes and environmental trajectories for natural features such as the Yarra Birrarung corridor because they present potential techniques for integrating beneficial outcomes (that is, environmental 'gain') within the design of particular 'policies or actions', including down the level of specific developments or land uses. They are amenable to urban planning. They pre-empt the need, in what we might term their contribution to urban 'greening' or 'health', for 'offsetting' measures, as they are intended to internalise environmental costs and benefits and achieve and, theoretically, achieve an overall environmental benefit.

Within these design approaches there are still calculations of resources to be dedicated to environmental, natural or restorative outcomes, as well as other (arguably, primary) outcomes, such as commercial profit, infrastructure uses, or ordinary development outcomes. Literature on 'green cities' and 'natural infrastructure' should also be read therefore in the context of economic and policy literature contending with the financing of nature in the urban sphere and the economics (including economic modelling) of ecology in urban landscapes. We do not think it prudent or possible in this Report to embark on a rather wayward journey in to studies of 'green financing', ecological economics or monetising nature-based transactions. That is a trek to Mordor for others to make. However, the issue of resources attached to strategic or landscape-scale change focused on essentially public interest (environmental and cultural) outcomes should be the topic of some consideration. A brief review of literature informing urban 'greening' and design suggests:

- Mobilisation of resources is required to achieve outcomes and gains and this should be underpinned by a robust and defensible methodology (science), having regard to the broad array of public interest benefits and public goods typically at issue in landscape planning at scale.

[211] See eg Melbourne Water 'Water sensitive urban design', https://www.melbournewater.com.au/building-and-works/stormwater-management/introduction-wsud

[212] CSIRO *Urban stormwater: best practice environmental management guidelines* (1999), Ch 5; Wong and Brown 'The water sensitive city: principles for practice' (2009) 60 *Water Science and Technology* 3 673

- Various policy devices may be appropriate to this mobilisation of resources, ranging from, for example, statutory levies or charges, transactional tools (such as offsets), public appropriations, philanthropic funds, or ‘social investing’.
- A defined financing or resourcing facility may be appropriate to the organisation of investment (the holding, planning and distribution of resources), which may be a unique entity or a collaboration (network) dedicated to the ‘net gain’ program.
- Investment and resource planning consistent with strategic planning.
- Performance oversight and reporting, which could be aimed not only at financial or even environmental performance of investment programs but additionally the development and refinement of performance indicators and measurement.

2.2 Review of literature 2: Ecological restoration

The literature concerning ecological restoration is equally, if not more, voluminous than that concerning environmental economics and offsets. Clearly, each field of inquiry is connected: biodiversity compensation presumes modes and models of ecological repair, whether in terms of (re)establishing habitat or creating carbon 'sinks'. However, restoration literature and practice is a stand-alone field, traversing subject-matter well beyond its connections to offsetting or compensation schemes. The knowledge base of ecological restoration is multidisciplinary and includes biological sciences, law, policy, sociological theory and practice, and governance sciences.

The particular relevance of ecological restoration literature to the Yarra Birrarung lies in the focus in law, policy and practice on long-term achievement of 'health' of a 'living' river across the landscape (corridor) scale. This task is consistent with a process of human intervention in the process of 'recovery of an ecosystem that has been degraded, damaged or destroyed' as well as enabling the shift of a 'degraded ecosystem to a trajectory of recovery that allows adaptation to local and global changes, as well as persistence and evolution of its component species.'[213] Ecological restoration functions on a continuum of interventions aimed at improving environmental and landscape conditions, ranging, in terms of effect, from reduced societal impacts, to remediation and rehabilitation, through to ecological restoration.[214] The former are activities 'allied' to restoration within a 'broad sustainability paradigm'.[215] The epitome of this approach is the so-called 'five star' standard of recovery of 'self-organising trajectory to full recovery…'[216]
The notion of an environmental 'net gain' is explicitly linked to the task of ecological restoration:

> Although protecting remaining native ecosystems is critical to conserving the world's natural and cultural heritage, protection alone is insufficient, given past and current degradation. To respond to current global environmental challenges and to sustain the flow of ecosystem services and goods essential for human wellbeing, *global society must secure a net gain in the extent and functioning of native ecosystems by investing not only in environmental protection, but also in environmental repair including ecological restoration*. This repair must be implemented at multiple scales to achieve measurable effects worldwide. [emphasis in original]

A presumption of human intervention in the fate of 'trajectories' of ecological function or 'health' raises the questions as to the 'restoration inputs' comprising that level and nature of intervention in any given circumstance.

We caution that the rich vein of ideas, techniques and examples of ecological restoration cannot be fully mined here, for lack of space. However, the depth and imagination of restoration literature should, in our view, be more fully explored across the Yarra Birrarung landscape. For present purposes, we draw attention to certain features and compelling insights from this literature worthy of immediate consideration.

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[213] Society for Ecological Restoration International *Principles and Standards for the Practice of Ecological Restoration* (2nd ed, 2019), 15 ('SER International Restoration Standards')
[214] SER International Restoration Standards
[215] Ibid, 49
[216] Cliquet and Decleer 'Halting and restoring species loss: incorporating the concepts of extinction debt, ecological trap and dark diversity into conservation and restoration law' (2017) 26 *Griffith Law Review* 2 178, 191

International and national guidance on ecological restoration is noted below, as key compilations of restoration theory and practice, but proper and effective interrogation of this theoretical space should be undertaken with regard to other definitive sources:

- International peer-review journals, in particular Restoration Ecology and Ecological Restoration
- Extensive 'grey' literature (reports, case studies and other proceedings) on restoration projects and thinking, such as led by international organisation including the IUCN
- Growing body of texts and editions covering scientific and interdisciplinary work on restoration ecology, going back now several decades.

2.2.1 Restoration principles and standards

Authoritative guidance on ecological restoration has been developed at the national and international level.
The 2019 International Standards presently hold the greatest currency. These Standards set out core high-level matters for application to restoration programs or schemes. These include:

Ecological restoration must engage stakeholders.
A key message is the need to recognise the socio-ecological character of restoration. 'Engagement' needs also to be considered in relation to the ethical, organisational and governance imperatives.

Restoration will be based on multiple sources of knowledge.
While scientific knowledge is critical, both in terms of physical and social sciences, both local community knowledge and frequently indigenous (cultural) knowledge and science are integral to restoration programs. These comprehensive bodies of knowledge are important to understanding both biophysical and social dimensions of the restoration exercise. The broad knowledge base is also relevant to enabling the collaborative basis for restoration programs.

Ecological restoration must be informed by an appropriate reference ecosystem, within the context of environmental change.
The device of the reference model, condition or state is crucial to restoration. It should not be misunderstood. It is not necessarily an historic state (for example, pre-1788 ecosystems in the Australian context). Formation of an appropriate reference model will require multiple inputs and set out the intended trajectory and goal for the restoration program or scheme. It is an approximation of a desired state. There may be more than one reference model. Reference conditions need to account for climate change and for inherent dynamism in ecological systems, allowing for recovery, adaptation, evolution and reassembling of species and communities. Reference models will also be established in relation to baselines or 'starting points'.

Restoration supports ecosystem recovery processes.
Restoration is intended facilitate recovery of natural processes, based on greater or lesser interventions over time: 'Restoration activities focus on reinstating components and conditions suitable for these processes to recommence and support recovery of ecosystem attributes, including capacity for self-organization and for ecosystem resilience to future stresses.'[217]

[217] SER International Restoration Standards, 32

Ecosystem recovery is assessed against clear goals and objectives, using measurable indicators.
This Standard takes account of best practice planning methods and science in restoration projects or schemes, as well as assessment of performance and capacity for adaptation and adjustment.

Restoration seeks the highest level of recovery attainable.
Recovery outcomes will be a product of ambition as well as circumstances. The Restoration Standards set out a structured approach to directing restoration effort, based on a 'five-star model' and the 'ecological recovery wheel' incorporated performance against key ecosystem attributes.[218]

Ecological restoration gains cumulative value at scale.
All restoration projects are valuable but there are accumulating and self-reinforcing benefits to undertaking restoration programs at landscape or regional scale.

Restoration is part of a continuum of restorative actions.
Restoration should be considered as activities governed by a logic of ecosystem recovery (from initiating to achieving recovery fully) but not detached from other strategies contributing to or enabling trajectories of ecosystem health, including reducing impacts, improving ecosystem management and repairing ecosystem function.[219] Each set of actions can be considered a form of environmental 'gain' and therefore measurable contributions to 'net gain' at scale (such as the Yarra Birrarung corridor).

The SER standards provide a framework and foundation for understanding restoration as practice and as a focal point (substance) of 'gain' in the present context.

The restoration literature highlights certain other important findings and themes.

2.2.2 Australia's national principles and standards

Australian national restoration principles and standards have been prepared and published alongside international principles and standards. The most recent national approach slightly pre-dates the current international document. For this reason, as well as the leading role of the International Principles and Standards, we have tended to focus on the latter in this report. However, the better approach is to consider these documents jointly. Both represent important attempts to distil thinking on the systematic theoretical and practical approach to restoration.

[218] Ibid, 43-44. Relevant attributes for recovery include: absence of threats, physical conditions, species composition, structural diversity, ecosystem function, and external exchanges. Star-based recovery outcomes are: ongoing deterioration prevented (1 star); threats from adjacent areas starting to be managed or mitigated (2 stars), adjacent threats being managed or mitigated and very low threat from undesirable species onsite (3 stars); a substantial subset of characteristic biota present (representing all species groupings), providing evidence of developing community structure and of ecosystem processes (4 stars); establishment of a characteristic assemblage of biota to a point where structural and trophic complexity to a level of very high similarity to the reference ecosystem is likely to develop with minimal further restoration interventions (5 stars).
[219] Ibid, 50.

The six principles of ecological restoration set out in the national document include:

- Ecological restoration practice is based on an appropriate local indigenous reference ecosystem
- Restoration inputs will be dictated by the level of resilience and degradation
- Recovery of ecosystem attributes is facilitated by identifying clear targets, goals and objectives
- The goal of ecological restoration is full recovery, insofar as possible, even if outcomes take a long time or involve high inputs
- Restoration science and practice are synergistic
- Social aspects are critical to successful ecological restoration.

As with the international standards, the concept of restoration is understood as comprising part of a spectrum of actions directed to 'environmental repair': see Figure 4. This model spectrum is viewed as specifically relevant to urban or production (highly modified) landscapes. Ecological restoration is the preferred course of action from a point at which there is feasibility and intent to restore landscapes according to local reference models. 'Reduction of impacts' and 'rehabilitation' reflect intentions that might be described as ameliorative and improving respectively but absent recovery outcomes based on a reference model. It could be said there are parallels between the 'overall improvement' approach of Victoria's Biodiversity Strategy and the ameliorative and rehabilitative ambitions on this spectrum. The 'pyramid' of environmental repair also reflects the cumulative character of these recovery strategies, including the capacity for ameliorative and rehabilitative ambitions to anticipate and pre-empt restoration.

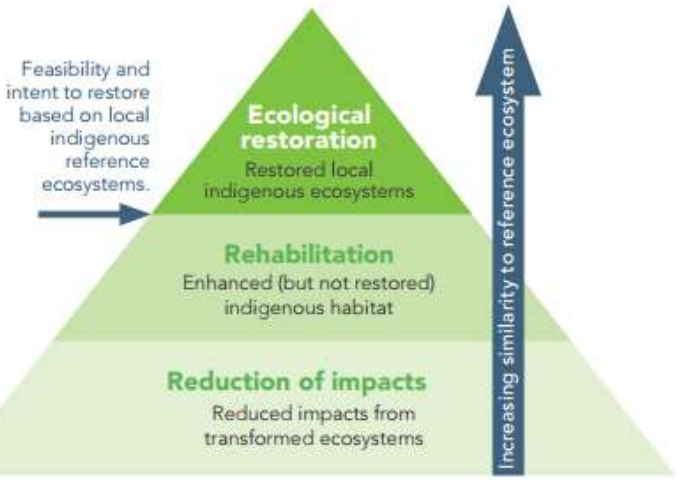

Figure 3 Broader context of 'environmental repair'. Ecological restoration fits within a range of complementary activities undertaken by various sectors of society to repair damage to the broader environment, with the broader context referred to in the Standards as 'environmental repair'. The pyramid arrangement depicted here applies only to transformed urban or production landscapes where the degree of success or failure of ecological restoration will be greatly influenced by the degree of success or failure of rehabilitation and reduction of impacts.

Figure 2: Spectrum of environmental repair, Australian national restoration standards. Source: Standards Reference Group SERA National Standards for the Practice of Ecological Restoration in Australia (2017), 31

2.2.3 Landscape-scale restoration

Restoration frequently operates at landscape-scale, including under the aegis of a common 'project'. This can occur on vast scales. Landscape restoration projects provide innumerable

examples, lesson and case studies.[220] Typically, successful projects are characterised by multi-level and 'nested' governance, multi-actor and cross-sector *collaboration* from the 'bottom up' and 'top down' concurrently, a leading role for community organisations, cross- or multi-tenure operation, development of fit for purpose planning models, and diverse funding sources.

An important focus of landscape-scale restoration projects is connection of landscapes, alongside connection of communities. They are typically both community development exercises in practice and a long-term, often geographically expansive, intention to respond to historic fragmentation of landscapes. This refers specifically to overcoming and, to the maximum practicable degree, reversing loss of ecosystem connectivity in landscapes. Projects will often build on intact landscape features, such as protected areas, and available sources of connectivity, for example remnant biodiversity along roadsides and along waterways. These sites and connections can be used over time as a basis to 'infill' degraded areas and re-establish ecological function. These objectives are supported by Victoria's planning system,[221] including specifically in the Yarra Birrarung corridor.[222]

2.2.4 Reference model(s) as a key device

The concept of an ecological reference is a pivotal device to restoration ecology. It has been referred to as a 'cornerstone concept'.[223] The reference model is the underpinning guidance and target for the ecological restoration scheme. A variety of analogous terms are used alongside reference model, such as reference ecosystem or reference state. The reference model and its construction are central to restoration theory and practice because they provide the ambit, albeit often worked out in considerable detail, of the progressive, forward-looking scheme for restoration in any particular project or program. The reference model becomes the object of the restoration trajectory sought. It is perhaps not accurate to conflate reference model and 'vision', although the latter can form part of the former: the reference is a more systematically informed and thought-through construct, building on vision: 'Every ecological restoration project begins with a vision of how the restored ecosystem will eventually appear. Ideally, this vision is expressed in a reference model that is described in a written statement in project plans… Reference models clarify important questions about what should be restored and why…'[224]

The reference model is a key device distinguishing theories and strategies of restoration from other approaches to ecological change (for example, rehabilitation strategies and theories of ecological enhancement or 'improvement'), in that restoration relies on a framework of

[220] See eg Carina Wyborn 'Landscape scale ecological connectivity: Australian survey and rehearsals' (2011) 17 Pacific Conservation Biology 121; Figgis et al 'Conservation on private land in Australia' (2005) 15 Parks 2 19; Fitzsimons et al *Linking Australia's Landscapes: Lessons and Opportunities from Large-Scale Conservation Networks* (CSIRO, 2013); Worboys et al Connectivity Conservation in Australian Landscapes (DSEWPAC, 2011); Tryzna et al *Urban Protected Areas: Profiles and Best Practice Guidelines* (IUCN, 2014)

[221] See *Victoria Planning Provisions*, cl 12.01-1S (Protection of biodiversity): 'Assist in the establishment, protection and re-establishment of links between important areas of biodiversity, including through a network of green spaces and large-scale native vegetation corridor projects.'

[222] *Victoria Planning Provisions*, cl 12.03-1R: 'Strengthen the Yarra River's natural environment, heritage and overall health by… Protecting and enhancing both terrestrial and aquatic habitats and their linkages along the river corridor'

[223] Balaguer et al 'The historical reference in restoration ecology: re-defining of cornerstone concept' (2014) 176 *Biological Conservation* 12

[224] Clewell 'Guidelines for reference model preparation' (2009) 27 *Ecological Restoration* 3 244, 244

change (trajectory) directed to an articulated 'template of historical or natural conditions': the reference model is an intentional, actual, often qualitative and quantitative, depiction of recovery. It is a form of concluded target-setting for the restoration scheme.

The reference model is conceptually important to restoration ecology in its framing of the restoration project or program, but moreover its importance also lies in its practical antidote to a reminiscent or mythic approach to restoration. The reference model is, in effect, an *instrument* that has to be constructed and it is not, by contrast, a caricatured or nostalgic figure of *les temps perdu*.

The construction of such an instrument can, indeed often should, rely on multiple sources, including pre-existing, historic, degraded or even lost ecosystems or ecological features. In many, if not most, instances, the reference model will include actually existing intact ecosystems as key focal points. Analogues to intact ecosystems are also often used in order to frame reference models – the description of Ecological Vegetation Classes (EVC) benchmarks in Victoria has long assumed the function of this type of analogue. Past and continuing ecosystem characteristics inform reference models in the real, objective sense of comprising part of the 'ecological memory'[225] of the landscape, which is the material and informational persistence of ecological systems after disturbance and which is thereby fundamental to questions, for example, of resilience and hence 'resilience debt'[226] within natural landscapes. Responsiveness to extant ecological memory and narrowing resilience debt in the landscape can be essential to the construction of reference models and hence the (targeted) program of change (recovery).

Debate around the reference model tool in restoration ecology has focused in particular on its relationship and connection to the inherent complexity and dynamism of ecological systems. That dynamism is amplified by uncertainties and volatility associated with climate shifts and non-linear change. The treatment of reference models is closely associated with insights into theories of trajectory in restoration science: in essence, that ecological restoration may need to accommodate multiple trajectories of change and/or adjustment in trajectory. Having regard to these realities, restoration science has looked to concepts of 'dynamic reference models'[227] or 'alternative stable states'[228] to accommodate degrees of variability in ecosystems as they respond to restoration actions and as recovery trajectories unfold. These concepts could be said to be allied to those such as 'adaptive restoration'.[229]

Finally, it is simplistic to pose an imagined past ecological state as a proxy for a desired (referenced) future ecological state. Restoration science contends with this problem at length, recognising concurrently that it is not sufficient or straightforward alternatively to pose the

[225] Johnstone et al 'Changing disturbance regimes, ecological memory and forest resilience' (2016) 14 *Frontiers in Ecology and the Environment* 7 369; Hughes et al 'Ecological memory modifies the cumulative impact of recurrent climate extremes' (2019) 9 *Nature Climate Change* 40
[226] Johnstone et al 'Changing disturbance regimes, ecological memory and forest resilience'
[227][227] Kirkman et al 'A dynamic reference model: a framework for assessing biodiversity restoration goals in a fire-dependant ecosystem' (2013) 23 *Ecological Applications* 7 1574
[228] Suding et al 'Alternative states and positive feedbacks in restoration ecology' (2004) 19 *Trends in Ecology and Evolution* 1 46
[229] Zedler et al 'Shifting restoration policy to address landscape change, novel ecosystems and monitoring' (2012) 17 Ecology and Society 4 36; Zedler 'Ecological restoration: guidance from theory' (2005) 3 *San Francisco Estuary and Watershed Science*, 10.15447/sfews.2005v3iss2art4

'past as prologue'[230] to future recovery outcomes and targets. At the same time, restoration science has sought to grasp the actual dynamic and function of the ecological 'past', such as in concepts of 'ecological memory', in intentional ecological futures – that is to say, policy and programs. The reference model mechanism plays an important role in reconciliation of time and temporal space in ecological restoration.[231]

2.2.5 Recovery outcomes: the 5-star recovery system and ecological complexity, functionality and diversity

Intentional ecosystem restoration, through programs and policies, is intended to enable natural processes and conditions of ecological functioning. Restoration is the task of intervening in order to enable recovery:

> Ecological restoration actions are designed to assist natural processes of recovery that ultimately are carried out by the effects of time on physical processes and the responses and interactions of the biota throughout their life cycles. Restoration activities focus on reinstating components and conditions suitable for these processes to recommence and support recovery of ecosystem attributes, including capacity for self-organization and for ecosystem resilience to future stresses.[232]

What should be clear is this approach is not an attempt at *design* of landscapes or ecological systems. It is a programmatic approach to engagement with 'natural recovery potential',[233] which can be addressed through various strategies, depending on, for example, degrees of degradation of natural conditions.[234] Charting recovery pathways, including constructing reference models and planning, concerns guidance, not design blueprints, and it is intended to serve restoration not environmental engineering.

A central principle of restoration ecology is that ecosystem recovery can be understood within an ordered and structure, if cumulative, *scheme of recovery* and it is not, therefore, conceived as part of abstract, arbitrary or ad hoc actions. This scheme of recovery is identified with a '5 star recovery system', orientated to the 'highest level of recovery attainable'.[235] The model recovery scheme established under national and international guidance involves a matrix of discernible, high-level, recovery outcomes, measured in relation to discrete ecosystem attributes 'along a trajectory of recovery'.[236] Those ecosystem attributes are identified as:[237]

- Absence of threats
- Physical conditions
- Species composition
- Structural diversity
- Ecosystem function
- External exchanges

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[230] Hiers et al 'The dynamic reference concept: measuring restoration success in a rapidly changing no-analogue future' (2012) 30 Ecological Restoration 1 27
[231] See also Richardson 'Timescapes of ecological restoration' in Akktar-Khavari and Richardson (eds) *Ecological Restoration Law: Concepts and Case Studies* (Routledge, 2019)
[232] SER International Restoration Standards, 32
[233] Ibid
[234] Ibid, 68-69
[235] Ibid, 40-45; SERA National Standards for the Practice of Ecological Restoration in Australia (2018), 13-15
[236] Ibid, 42
[237] Ibid, 42-43

The high-level recovery outcomes are basic qualitative measures of ecosystem conditions as reproduced in Figure 5. In application to specific programs or projects outcome can have qualitative and quantitative expression. Recovery outcomes and conditions are understood as cumulative. They are broadly representative of ecosystem conditions that trend toward what might be described as 'healthy' – that is to say, the trajectory reflected in the '5 star' system is comparable to progress toward 'ecosystem health'. Attainment of recovery outcomes, under this restoration ecology approach, can be employed as a surrogate for 'ecosystem health'.

International guidance has also been prepared in relation to the development and management of restoration projects, which traverses and disaggregates 51 actions or tasks definable across the planning and delivery cycle, from conceptualisation to post-implementation.[238]

NUMBER OF STARS	SUMMARY OF RECOVERY OUTCOME
★	Ongoing deterioration prevented. Substrates remediated (physically and chemically). Some level of native biota present; future recruitment niches not negated by biotic or abiotic characteristics. Future improvements for all attributes planned and future site management secured.
★★	Threats from adjacent areas starting to be managed or mitigated. Site has a small subset of characteristic native species and low threat from undesirable species onsite. Improved connectivity arranged with adjacent property holders.
★★★	Adjacent threats being managed or mitigated and very low threat from undesirable species onsite. A moderate subset of characteristic native species is established and there is some evidence of ecosystem function commencing. Improved connectivity at the landscape scale is in evidence.
★★★★	A substantial subset of characteristic biota present (representing all species groupings), providing evidence of developing community structure and of ecosystem processes. Improved connectivity established and surrounding threats being managed or miti-gated.
★★★★★	Establishment of a characteristic assemblage of biota to a point where structural and trophic complexity to a level of very high similarity to the reference ecosystem is likely to develop with minimal further restoration interventions. Appropriate cross-boundary flows are enabled and commencing and resilience is restored with return of appropriate disturbance regimes. Long-term management arrangements in place.

Figure 3: SER 5 Star Recovery System. Source SER *International Principles and Standards for the Practice Ecological Restoration* (2019), table 3, 41

2.2.6 Ecological theory and ecological restoration

A key strength of restoration ecology as a discipline is its patently close alignment with ecological theory. Specifically, restoration science and practice appears strongly responsive and alert to the dynamism of ecological systems. This fact is perhaps unsurprising given the historic close association between theory and practice in this field. Restoration ecology tends to conduct itself as a form of real-world experimentation.

[238] Clewell et al *Guidelines for Developing and Managing Ecological Restoration Projects* (2nd ed, Society for Ecological Restoration International, 2005), https://www.ser.org/resource/resmgr/custompages/publications/ser_publications/Dev_and_Mng_Eco_Rest_Proj.pdf

Ecological theory in its broadest sense concerns 'spatial and temporal patterns of the distribution and abundance of organisms, including causes and consequences'.[239] For many years a general theory of ecology has been the subject of debate and refinement. Scheiner and Willig propose seven fundamental principles of a general theory of ecology. These are reproduced in Figure 6. Within this notion of an overarching ecology theory there are numerous, more specific ('constituent') ecological theories, which seek to contend with specific ecological phenomena and characteristics of ecological systems.[240]

Table 2 The seven fundamental principles of the general theory ecology and the rules that determine their inclusion

Seven fundamental principles
1. Organisms are distributed in space and time in a heterogeneous manner. [inclusionary rule]
2. Organisms interact with their abiotic and biotic environments. [inclusionary rule]
3. The distributions of organisms and their interactions depend on contingencies. [exclusionary rule]
4. Environmental conditions are heterogeneous in space and time. [causal rule]
5. Resources are finite and heterogeneous in space and time. [causal rule]
6. All organisms are mortal. [causal rule]
7. The ecological properties of species are the result of evolution. [causal rule]

Figure 4: Seven fundamental principles of a general theory of ecology.

Source: Scheiner and Willig 'A general theory of ecology' (2008) 1 *Theoretical Ecology* 21

If this approach can be distilled summarily it may be that ecological systems are dynamic, complex, and function across multiple possible domains and scales. While ecological theory has previously posited, inspired by theories of entropy, that system behaviours tend toward equilibrium or 'steady states', this approach is contested by understandings of ecosystems as inherently tending to 'non-equilibrium' or shifting states.

One key consequence of these overarching characteristics of ecosystems is that it is problematic and limiting (reductionist) to confine models of natural systems to particular, discrete phenomena or properties, or to particular causal conditions, without regard to the wider and inherent system complexity and dynamism.

Restoration ecology imposes a certain, distinctive 'lens' on ecological theory: as a (sub)discipline, it promulgates an approach associated with ecosystem *recovery*. It is, in effect, the theoretical and conceptual arm of a movement of science and practice. Building on wider ecological theory and sciences, restoration ecology gives particular application, as well as potentially emphasis and design, to ecological theory.

For example, theories of ecological change can have a specific resonance in restoration ecology. Ecological sciences identify forms of linear and deterministic change (simple cause-

[239] Scheiner and Willig 'A general theory of ecology' (2008) 1 *Theoretical Ecology* 21, 23; Scheiner and Willig (eds) *The Theory of Ecology* (University of Chicago Press, 2011)
[240] Scheiner and Willig refer to these as constituent theories. They include for example island biogeography theory, succession theory, population dynamic theory, niche theory, food web theory, or metabolic theory: Scheiner and Willig 'A general theory of ecology' (2008) 1 *Theoretical Ecology* 21, 26

effect relationships) but also, perhaps predominantly, non-linear, 'shifting' change such as ecological succession or collapse. Thresholds or 'tipping points' is these dynamics are fundamental. For restoration ecology, an understanding these dynamics and relevant thresholds (including in quantifiable form) can be crucial to models, planning and action in order that theories of change best align with actual conditions of change.

Similarly, ecological theories of disturbance, trophic complexity (food webs), or stochasticity each have important resonance in restoration ecology. Disturbance concerns forms and patterns of disruption in ecological systems, usually where temporary impacts cause wider changes in ecosystem functioning, structure or composition. Natural disturbances include fire, flooding or invasive species impacts. Anthropogenic disturbances are widespread. Restoration ecology aims to consider and respond to both negative and positive disturbances in order to enable recovery. Disturbance can be associated with stochastic events, which are unpredictable or random phenomena effecting ecosystems. Stochasticity is widespread in ecological systems. Trophic complexity concerns diversity and multifunctionality of food webs. This type of complexity is fundamental to ecosystem functioning and processes, as its concerns the circulation and cycling of nutrients within ecosystems, across multiple scales. For example, trophic systems function within soils via complex biotic and abiotic interactions in soil ecologies. An interesting example of these interactions in Australian ecosystems is the 'keystone' role of 'digging marsupials' in maintaining soil health. Predator cascades function as a basis of stabilising and regulating ecological structures. These trophic phenomena have been notorious in 're-wilding' processes, where the role of 'apex' predators in ecosystem balance is highlighted. Human interventions directed to re-establishing trophic complexity can be important to restoration ecology. Complexity itself will be important to ecological integrity and, typically, resilience of ecological systems. Hence measures of complexity may be prominent in assessing restoration outcomes or performance.

A third area of ecological theory exemplifying specific application to restoration ecology concerns concepts associated with temporal (time-based) dynamics within ecosystems. Given restoration ecology is strongly directed to improved changes over time, these phenomena can be especially important. Ecosystems can evidence patterns of resilience or delayed responses to impacts and interventions. Delayed or 'lag' effects can be produced by disturbance impacting on ecosystems without its effect or consequence being manifest, wholly or in part, until sometime later. For example, ecosystems can retain species populations after profound disturbance, but landscape conditions are sufficiently impaired so as to lead to substantial, eventual loss or decline trajectories. This phenomenon is associated with extinction debt.[241] Landscapes can also retain key ecological qualities following substantial disturbance, which may be latent until appropriate conditions trigger their re-establishment. This phenomenon can be associated with concepts of 'ecological memory' in landscapes.[242]

Ecological theory has a fundamental role to play in the science and practice of restoration ecology. Its importance relates to an effective understanding of ecosystem dynamics in order that human interventions are well-grounded, justifiable and are, in fact, likely to contribute to recovery, or 'measurable improvement' in terms set out in agreed ambitions and targets.

[241] See eg Kuusaari et al 'Extinction debt: a challenge for biodiversity conservation' (2009) 24 *Trends in Ecology and Evolution* 10 564

[242] See eg Johnstone et al 'Changing disturbance regimes, ecological memory, and forest resilience' (2016) 14 *Frontiers in Ecology and the Environment* 7 369

From the perspective of design of restoration programs, effective understanding of ecological theory and concepts will be essential to choices over the 'tools' to be used, such as *what* ecological phenomena or properties are measured, *how* recovery or change is to be measured, and how that should inform indicators, targets and 'performance'.

2.2.7 Ethics, community development and organisation: the subjective expression of restoration

A critical and oft-neglected factor in ecological restoration programs and agenda is what we might refer to as the subjective expression of restoration. This is arguably distinct from the 'objective' expression of ecosystem and natural recovery. There are broadly three aspects to this subjective expression of restoration: its social organisation, its ethical (and potentially psychological) expression, and its cultural form. These factors are important to what we might term the 'relational' aspects of ecological restoration. This base of restoration is reflective of a major shift in norms and patterns of behaviour in 'settler' Australia over the past half-century, albeit it not without shortcomings.[243]

Restoration schemes are often expressed as cultivating and based on norms of stewardship, custodianship, trusteeship or guardianship of place. These relationships may or may not be institutionalised, such as through formal recognition of a public interest body as custodian or guardian. What is defining however is that restoration will be underpinned by a distinctive ethic and relationship. Restoration typically requires strong ethical or normative bases, alongside administration and planning.

Social and cultural connections and understandings of the natural world enliven both a historical reservoir of knowledge of particular parts of the world and deep understandings of the place of human beings in the natural world which cannot easily be measured and quantified through scientific methods. Ensuring that cultural relationships to the Yarra are maintained and strengthened is not just about justice it's also about ensuring that we can continue to make good decisions about the river as a whole and one that is suited to the area, rather than relying on commercial and scientific tools that may serve sectional interests.[244]

How do we measure 'net gain' in relation to these 'subjective' and 'relational' qualities of environmental improvement and restoration? There are various qualitative and quantitative indicators that can be developed for this purpose, such as:

- Social and cultural indicators of success, including organisations involved in the restoration program and their memberships
- The scale and durability of these organisational networks and their engagement
- Number and nature of collaborations

[243] See eg Campbell, et al 'Reflections on four decades of land restoration in Australia' (2017) *The Rangeland Journal* 39 405, 405:

> Over the past four decades the rising culture of landscape restoration has profoundly affected the nation's relationship with our continent. A land restoration ethos–some call Landcare–has enthused communities, infused into policies and public agencies, and diffused through the countless networks and locales where it continues to flourish. Our practices and culture have changed. We more deeply respect, understand, appreciate, and celebrate our landscapes, with their intricate richness and profound diversity. In setting out to change landscapes we ourselves, both as individuals and as Australian people, have changed.

[244] See Campbell, J et al 'Reflections on four decades of land restoration in Australia' (2017) *The Rangeland Journal* 39 405

- Diversity of social and cultural purposes
- Broader awareness, engagement with and use by the general public with restoration programs.

Comparable forms of measurement and assessment will have been developed in the context of existing, often long-term, restoration programs, such as Landcare.

An important qualitative and strategic indicator of the 'subjective' base for landscape restoration can be found in collaborative planning. For the Yarra Birrarung this factor has extensive statutory support, in the form of the community-generated 'vision' and legislated strategic planning which requires a high degree of public participation (reflected both in the principles of the Act as well as requirements for a public inquiry process on the draft Yarra Strategic Plan). Models of collaborative planning have been developed expressly for large-scale, collaborative landscape restoration projects, such as The Nature Conservancy's 'Conservation Action Planning'.[245] This model is used directly in NRM planning in South Australia.[246] There are numerous NRM planning arrangements in operation already under statutory schemes, such as Melbourne Water's 'co-design' programs for waterways, 'regional catchment strategies' and recovery planning for threatened species. Victoria biodiversity policy currently refers to 'biodiversity response planning' as the mechanism for implementing the Biodiversity Strategy.

Key distinguishing features in conservation planning representative of the social and 'subjective' base of restoration include, arguably:

- extent and degree of community participation,
- the number and diversity of interests actively involved,
- the durability of networks and planning processes,
- the various 'axes' of collaboration (community-agency, community-expert/researcher, community-NGO, agency-NGO, etc),
- appropriate and proportionate distribution of *authority* within collaborations, and
- formal and informal (practical) dynamics that reflect and enable the *agency* of actors in decision-making, agenda-setting and delivery.

2.2.8 Restoration as a response to to change and innovation

Restoration science, practice and technique is not static. As more restoration schemes are developed and implemented they generate their own lessons, and these can then be considered or incorporated in maturing projects or new projects. Restoration is akin to an ongoing experiment in action. Knowledge does mature and deepen, or ebbs and flows (like, for instance, the renaissance in Indigenous knowledge systems), but it does not stand still.

In highly modified, fragmented or degraded ecosystems, such as in urban context like the Yarra Birrarung, a dialogue between scientific concepts and practice, on the one hand, and law, policy and institutions, on the other hand, will be crucial in implementing trajectories of recovery. Well-established principles and techniques will sit alongside innovation, where

[245] Carr et al 'Capitalising on conservation knowledge: using Conservation Action Planning, Healthy Country Planning, and the Open Standards in Australia' (2017) 18 *Ecological Management and Restoration* 3 1
[246] Landscape South Australia 'Community action planning – a landscape approach', https://landscape.sa.gov.au/ny/about-us/about-nrm/community-action-planning

there is sufficient 'safety' or resilience in ecological systems to undertaken them. In urban systems, these approaches will be necessary because re-establishing past reference points is typically not feasible and the intention is to restore ecosystem function and properties based on appropriate reference models.

Emerging or novel ecological concepts will be grasped and integrated into legal and policy thinking. In the climate change context, for example, this dynamic has been underway for some time, such as in legal adoption of concepts such as carbon 'sinks' and climate refugia. For restoration law and policy the situated appears less evolved. For example, integration of scientific concepts such as 'extinction debt' and 'ecological traps', signifying complex dynamics in ecological systems under stress, are still working their way into law and policy.[247] This is equally true of the social sciences as of biophysical sciences, such as accommodation in restoration policy of behavioural insights into communities or relevant social actors.[248] Indeed, existing Victorian conservation policy includes significant reliance on both the social benefits of nature and the role of urban biodiversity,[249] but seemingly absent comparable social-scientific rigour as applied to the biophysical scientific models informing policy.[250]

2.2.9 Indigenous communities and restoration in cultural landscapes

Natural landscapes the subject of restoration programs are very often cultural landscapes. For Australia, as well as for other societies, this fact means that restoration, commenced or projected, occurs in the context of colonised landscapes, long the subject of war, expropriation of land and waters, clearances and displacement, and the loss or disruption of traditional economies and societies. Ecological restoration, especially at the landscape scale, needs to reconcile its science and practice to both the fact of pre-colonial landscape management and the distinctive socio-political context of the colonial experience. The reverberations of both phenomena are ongoing.[251] Restoration programs may intend to achieve both ecosystem recovery and social justice outcomes.

We deal more fully with Aboriginal knowledge and cultural context further below.

For the purposes of considering literature on ecological restoration it is important to note certain trends and practices within that literature. These include:

[247] Cliquet and Decleer 'Halting and restoring species loss: incorporating the concepts of extinction debt, ecological trap and dark diversity into conservation and restoration law' (2017) 26 Griffith Law Review 2 178
[248] Telesetsky 'Eco-restoration, private landowners and overcoming the status quo bias' (2017) 26 Griffith Law Review 2 248. There is an extensive literature on behaviours and motivations of landowners (especially rural landowners) in conservation, both in terms of voluntary schemes, such as Landcare, and conservation financing, such as through market-based instruments: see eg Moon et al 'Participation in biodiversity conservation: motivations and barriers of Australian landholders' (2011) 27 Journal or Rural Studies 3 331; Dayer et al 'Private landowner conservation behaviour following participation in voluntary incentive programs: recommendations to facilitate behavioural persistence' (2018) 11 Conservation Letters 2 e12394.
[249] Victorian Government Protecting Victoria's Biodiversity – Biodiversity 2037 (2017), Chs 4-6
[250] Ibid, Ch 3, Appendix 1
[251] Not only in western 'post-colonial' states, such as Australia, but in circumstances where ecological restoration is a strategic response to recent war and oppression in other states: see eg Zedler 'Integrating traditional ecological knowledge with adaptive restoration' (2016) 2 *Ecosystem Health and Sustainability* 6 e01222

- Within established principles and standards, accommodation and expression of the importance of traditional and local knowledge in restoration projects and programs, and the importance of cultural values as intrinsic to programs and participation.[252] Relevant Indigenous knowledge may be diverse in sources and form (for example, oral or written) and traverse disciplines.[253]

- Restoration can and should be pluralistic and cross-cultural in character, which depends on and enables hybrid or synthesis models of science and practice, including across language and epistemologies framed by language.[254] As a consequence, values and priorities in restoration programs and models will typically not be confined to biophysical considerations but are sociocultural in character and, specifically, as reflective of agency of Indigenous communities, their agenda for restoration and (re)connection to landscapes.[255] Key roles of Indigenous communities in restoration programs will also be reflected in collaborative governance and planning arrangements.[256]

- By extension cultural goals and objectives can be important in restoration programs, 'woven' with biophysical and nature-based objectives.[257] Cultural models, practices and resource uses, for example, may be crucial not only to sociocultural outcomes but function inherently with ecological outcomes, including as derived from cultural stewardship and governance of the landscape (for example, 'caring for country' model in Australia). Hence, restoration 'tools' can include re-establishment of cultural practices (for example, burning or wetland management) or overlap of 'cultural' keystone species with other keystone species.[258]

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2.2.10 Water ecosystems and restoration

Restoration ecology literature commonly focuses on both theoretical and conceptual frameworks of ecological systems, having regard to their change and repair, and ecological dynamics and change in relation to *specific types of ecosystems*.[259] Specific scientific and theoretical work exists in relation to water ecosystems, whether freshwater, estuarine or coastal and marine. Water ecosystems are highly diverse, in terms of structure, function, and

[252] SER International Restoration Standards, Principle 3, 23-25; SERA National Restoration Standards, Principle 6, 17
[253] See eg Freedman *Bulleen-Banyule Flats CVS*; Kurashima et al I Ka Wa Ma Mua: the value of a historical ecology approach to ecological restoration in Hawai'I' (2017) 71 *Pacific Science* 4 437
[254] Wehi et al 'Missing in translation: Maori language and oral tradition in scientific analyses of traditional ecological knowledge (TEK)' (2009) 39 *Journal of the Royal Society of New Zealand* 4 201; Walker et al 'Kaitiakitanga, place, and the urban restoration agenda' (2019) 43 *New Zealand Journal of Ecology* 3 3381; McAllister et al 'Kua takoto te manuka: matauranga Maori in New Zealand ecology' (2019) 43 *New Zealand Journal of Ecology* 3 3393
[255] See Lyver et al 'Key biocultural values guide restoration action and planning in New Zealand' (2016) 24 Restoration Ecology 3 314;
[256] Reyes-Garcia et al 'The contributions of Indigenous Peoples and local communities to ecological restoration (2019) 27 *Restoration Ecology* 1 3
[257] Wehi and Lord 'Importance of including cultural practices in ecological restoration' (2017) 31 *Conservation Biology* 5 1109
[258] Garibaldi and Turner 'Cultural keystone species: implications for ecological conservation and restoration' (2004) 9 *Ecology and Society* 3 1
[259] See eg Allison and Murphy (eds) Routledge Handbook of Ecological and Environmental Restoration (Routledge, 2017), Part II

extent. They traverse rivers and streams, alpine bogs, ephemeral wetlands, lakes, estuaries, and so on. They can range in size from several square centimetres to thousands of square kilometres.

Water ecosystems face particular and intense degradation pressures. These include wetland loss, hydrological modification and diversions, pollution and biochemical imbalances, species loss, trophic disruption, and degraded nutrient cycles. Interventions in each of these types of key cycles can be strategically important to restoration processes.[260] Water ecosystems are typically highly dynamic. For example, Australian freshwater river systems typically oscillate between extremes of flooding and drought, depending for system health on patterns of low flow and cease to flow events though to widespread overbank flow and lateral connectivity. High degrees of vertical (groundwater) connectivity may be crucial to restoration of freshwater systems also (although problematic for others, such as where saline coastal intrusions are a degrading influence). Loss of freshwater wetlands has been extensive in southern Australia, including along key river systems, through drainage and 'reclamation' works, land clearing and diversions for water supply and irrigation.

Freshwater system restoration of streams and wetlands is emerging as a focus of restoration activity in Australia, such as through reinstatement of wetlands lost to past drainage practices[261] and urban rivers are becoming a focus of sustained repair.[262] Certain restorative activities on urban rivers, for example, are extensions of past avoidance and reversal of past degradation, such as removal of polluting industries and improved stormwater management. While these interventions engage the 'prevention of degrading influences' part of the restoration spectrum, they have not yet necessarily progressed to *ecosystem restoration* schemes.

Wetland restoration has been a particular focus in countries such as the US, where regulatory and governance arrangements have driven wetland restoration programs. Law has driven restoration efforts through, for example, the Federal Clean Water Act, as well as intergovernmental water arrangements across internal (State and tribal) and international jurisdictional boundaries. Specific legislative and funding initiatives have attached to particular, off large-scale, wetland restoration programs, such as for the Great Lakes, Chesapeake Bay or the San Francisco Delta.[263]

Built on experiences with wetland restoration, the US EPA has prepared summary guidance on restoration principles for wetlands. These closely mirror other authoritative restoration guidance, including through consideration of protecting and preserving wetlands, restoring natural function, undertaking effective planning and target-setting (using reference models), and building toward self-organising ecological systems.[264]

Closer to the Yarra Birrarung, the Nature Glenelg Trust has been at the forefront on implementing an 'adaptive' restoration model directed to science and practice of wetland restoration. This work commenced with a focus on re-established drained wetlands in regional Victoria and South Australia and has since progressed to peri-urban contexts. They

[260] See eg Keddy 'Restoration of freshwater wetlands' in Allison and Murphy (eds) Routledge Handbook of Ecological and Environmental Restoration (Routledge, 2017), 243-260
[261] See eg Nature Glenelg Trust, http://natureglenelg.org.au/
[262] See eg Parramatta River Catchment Group, https://www.ourlivingriver.com.au/
[263] US EPA 'Wetland protection and restoration', https://www.epa.gov/wetlands
[264] US EPA 'Principles of wetland restoration', https://www.epa.gov/wetlands/principles-wetland-restoration

have extensively documented their work, including science and practice and their integration.[265]

2.2.11 Restoration in urban settings

Despite a common focus of restoration programs and projects in rural, productive or non-urban settings, ecological restoration literature does include express and specific consideration of application of science and practice to urban settings.[266] In some ways, ecosystem restoration in the urban context can be viewed as merely an extension of application to relatively degraded or disrupted natural conditions. Having said this, it is not uncommon that cities contain substantial areas of natural ecology within them or surrounding them, as we have considered above. This occurs even in rapidly urbanising centres.[267]

Arguably, urban ecological restoration is a more intensively socio-ecological exercise, given the proximity, indeed commonality, of large-scale human society, with its built environment, and natural systems. As we note elsewhere in this report, urban contexts are characterised by distinctive ecological conditions and science. Strong concurrences between Indigenous, urban and restoration considerations have been considered in the literature.[268] Nevertheless, an urban restoration ecology in discernible:

> Urban ecological restoration can similarly be distinguished from non-urban restoration by its necessary inclusion of humans and buildings into project design and implementation, as well as by two inescapable characteristics of the ecology of cities, fragmentation and the degree of alteration.[269]

The degree and extent of human impact on natural ecological processes, attributes and functioning in the city often means that overall outcome restoration seeks to achieve maybe distinguishable from full recovery of intact ecosystems:

> This scrum of constraints and influences not only sets urban ecological restoration apart from non-urban, it also changes the very project of restoration. Alongside classical restoration projects directed at re-establishing the key ecological structures and functions of times past and returning areas to a self-organizing and self-sustaining system, urban restoration projects are more often directed at protecting sensitive species, enhancing habitat for a wide range of species, and integrating human history into cultural landscape restoration... Urban ecological restoration projects are often designed to restore specific ecological services, a type of restoration also known as process-based, structural, or functional restoration... Restoration efforts might be narrowly focused on restoring specific ecological functions such as retaining and filtering water, providing habitat for insects, birds and fish, or supporting pollination.[270]

Insofar as the interactions of human and natural systems are of a particular character in cities, reflective of particular degrees in any given urban setting, it is not the case that high-level

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[265] Nature Glenelg Trust 'Publications', http://natureglenelg.org.au/ngt-resources/publications/
[266] Special issues of (2008) 26 Ecological Restoration 3, (2010) 5 Nature and Culture 3
[267] Yu et al ''Ecological restoration planning based on connectivity in an urban area' (2012) 46 *Ecological Engineering* 24, whose study focuses on Shenzen in southern China.
[268] Walker et al 'Kaitiakitanga, place, and the urban restoration agenda' (2019) 43 *New Zealand Journal of Ecology* 3 3381; Michel et al 'The reconnection between mana whenua and urban freshwaters to restore the mouri/lifeforce of the Kaiwharawhara' (2019) 43 *New Zealand Journal of Ecology* 33390
[269] Norris et al 'Ecological restoration in an urban context' in Allison and Murphy (eds) *Routledge Handbook of Ecological and Environmental Restoration* (Routledge, 2017), 372
[270] Ibid, 372-3

principles and methodologies for restoration do not apply. It is, rather, a matter of adaptation to the scales, impacts and opportunities presented.[271]

2.2.12 Restoration law

As this report infers, law presently responds poorly to the challenges of ecological restoration (the practice of restoration) and restoration ecology (the science of restoration). This fact is grasped by Akhtar-Khavari and Richardson in the open lines of their edition on 'restoration law':

> Ecological recovery has never been more important yet incongruously remains a low priority in environmental law. Most policy-makers perceive the intensifying upheavals of the Anthropocene as reasons to pay ever more attention to the future so as to forestall further degradation. Climate change, species extinctions, oceans of plastic debris and other ecological tolls loom on the horizon as an ever-real dystopia. We cannot ignore the urgency to halt dissipation of the life-sustaining biosphere, yet equally we should heal past losses in order to make sustaining what remains more viable.1 The Anthropocene is not a recent phenomenon but derives from a long history of anthropogenic environmental change that began at least with the onset of industrialisation two centuries ago and possibly earlier with the advent of agriculture. Under the aegis of the philosophy of sustainable development, which provides environmental law's conceptual ballast, regulators dwell on forestalling future adversity rather than addressing past follies. The legal priority is commonly to avert, mitigate or adapt to new ecological impacts rather than to repair past damage. This stance may also emotionally and culturally weaken people's sense of environmental stewardship on the presumption that nature has the capacity to passively restore itself through processes of ecological succession, species evolution and so forth. Damaged or degraded ecosystems sometimes can recover through their own processes, as evident in how nature rebounds after fires, floods or droughts; however, some recovery may be effectively impossible, such as when invasive species have fundamentally altered ecological equilibriums or toxic pollutants become embedded in land or water.

Environmental law is largely built on a premise of conditioning conventional conduct, especially as it concerns development or resource use, in order to align it with a relatively abstract benchmark of environmental quality. This approach is underpinned by concepts of 'sustainability' and ecologically sustainable development'.[272] Natural resource management law essentially regulates certain environmental factors, such as water, minerals or forests, for

[271] See SER International Restoration Standards, 30, 50-51 (Figure 5), 53 (Table 6); SERA National Restoration Standards, 30, 34-35

[272] See eg Australian Government *National Strategy on ESD* (1992), emphasis added:

> … While there is no universally accepted definition of ESD, in 1990 the Commonwealth Government suggested the following definition for ESD in Australia: 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased'.
>
> Put more simply, ESD is development which aims to meet the needs of Australians today, while conserving our ecosystems for the benefit of future generations. To do this, we need to develop ways of using those environmental resources which form the basis of our economy in a way which maintains and, where possible, improves their range, variety and quality. At the same time we need to utilise those resources to develop industry and generate employment.
>
> By developing this Strategy, we have demonstrated our belief that a coordinated approach to ESD is required. There are many reasons for this, including the need to look at management of Australia's ecological and economic resources on a regional, national and international basis, and the significance of potential threats to our environment and economy if we do not take action.
>
> *Governments recognise that there is no identifiable point where we can say we have achieved ESD.*

the purposes of their exploitation or extraction, with principles of sustainability now ordinarily added to those regimes.

Models of ecological recovery are typically absent in conventional environmental law, as Akhtar-Khavari and Richardson note, but so are legal concepts reflective of the dynamism and complexity of ecological systems. Law and policy struggle to comprehend ecology beyond the use of key ecological values, such as threatened species, hydrologies or habitat, as strategic surrogates for ecological conditions and functions.

At the same time, law and policy frequently invoke concepts of restoration and recovery in the management of biodiversity and ecosystems. For example, under the Victorian *Flora and Fauna Guarantee Act 1988* biodiversity objectives expressly focus on ecological recovery and restoration approaches to ecosystems generally:

> The objectives of this Act are—
>
> (a) to guarantee that all taxa of Victoria's flora and fauna… can persist and improve in the wild and retain their capacity to adapt to environmental change; and
>
> (b) to prevent taxa and communities of flora and fauna from becoming threatened and to recover threatened taxa and communities so their conservation status improves; and
>
> (c) to protect, conserve, restore and enhance biodiversity, including—
>
> (i) flora and fauna and their habitats; and
>
> (ii) genetic diversity; and
>
> (iii) ecological communities; and
>
> (iv) ecological processes; and
>
> (d) to identify and mitigate the impacts of potentially threatening processes to address the important underlying causes of biodiversity decline…[273]

Biodiversity restoration or improvement objectives can be found in planning policies under Victorian planning law. At the Commonwealth level, water legislation, including the Basin Plan, expressly refers to restoration of water ecosystems within the Murray Darling Basin and machinery of 'sustainable diversion limits', 'environmental watering plans' and 'water resource planning' is directed to those ends. Threatened species laws typically require preparation of recovery plans with the intention that they contribute to restoration outcomes for those species.

Each of these types of legal devices adverts to Parliamentary intentions to deploy the law in order to enable, if not achieve, ecosystem restoration or restoration of a key attribute of ecosystems (such as threatened species).

What does this mean for the content and form of environmental or natural resources law? In recent years environmental lawyers have increasingly turned their mind seriously to this question, such as Akhtar-Khavari and Richardson's edited volume *Ecological Restoration*

[273] *Flora and Fauna Guarantee Act 1988* (Vic), s 4

Law[274] and Amos' *International Conservation Law*.[275] A common theme throughout this work is that, not only has law generally failed to grasp the significance of accumulating (past) degrading impacts on the natural world in present and future actions, but it has a poor grasp of nature's time and functioning generally. Amos puts the limitations of law this way: there is a continuing anthropocentric priority of nature (plants) in law and policy over ecological systems, legal norms reinforce broad state sovereignty in the exploitation of natural resources, and law has failed to reflect rapidly developing ecological knowledge and science.[276] Many of the author's in Akhtar-Khavari and Richardson's volume similarly highlight that law in the environmental and natural resources fields appears relatively ossified and/or stagnant in the face of environmental challenges and ecological theory, lacking the wherewithal to tackle the full spectrum of issues and dynamics confronting human and natural systems. The editor's note: 'Environmental law has not kept pace with human beings' increasingly fast-paced reactions to being in the Anthropocene.' One of their contributors, commenting on arguably the key manifestation of the Anthropocene (climate change), writes: '… Australia's legal frameworks for restoration, by contrast [to adaptation-oriented approaches to restoring ecological health and function], are typically reactive, focused on a stationary and simplistic view of nature that assumes that harm can be 'undone' over relatively short timeframes.'[277]

These insights are reflective of a wider, powerful critique of environmental law that has emerged over the past decade: namely, that this field of law must come to terms with the actual dynamism of environmental systems and conditions.[278] The general approach of law dealing with the environment (and ecosystem more specifically) is that those conditions are fixed for the purposes of law and decision-making. Scholarship around climate change has increasingly challenged that model of 'stationarity' in law,[279] replacing it with concepts such as adaptation, although for the most part both domestic and international law has failed to respond to the challenge and builds in the assumption that the object of law (nature, or human-nature interactions) is fixed. This phenomenon is perhaps linked to the high value placed on order and finality by law and legal institutions, other than where the (slow) cumulative functions of common law or Parliamentary legislation progress change.

A second important and related critique of law we would note here, alluded to by Amos above, is the limited responsiveness of law (and policy) to ecological science and theory. For the purposes of this report, the point we make is that law and policy have primarily sought to respond to questions of environmental change principally by way of managing – and accommodating – environmental impacts, with regard to prospective amelioration of harms and interventions directed to repair, but with little or no accommodation of past and pre-existing ecological conditions, or to the dynamics of ecological systems. Restoration ecology includes a broad and evolving theoretical base looking to emphasize this ecological dynamism and how it functions within ecological change. Concepts such as trophic

[274] Ecological Restoration Law: Concepts and Case Studies (Routledge, 2019), building in a Griffith Law Review special issue: (2016) 26 *Griffith Law Review* 2
[275] *International Conservation Law: The Protection of Plants in Theory and Practice* (Routledge, 2020)
[276] Amos *International Conservation Law*, 6-7
[277] McCormack 'Reforming restoration law to support climate change adaptation' in Akhtar-Khavari and Richardson *Ecological Restoration Law*, 265
[278] See eg Craig et al 'A proposal for amending administrative law to facilitate adaptive management' (2017) 12 *Environmental Research Letters* 074018; MacDonald and Styles 'Legal strategies for adaptive management under climate change' (2014) *Journal of Environmental Law*, doi: 10.1093/jel/equ003
[279] Craig '"Stationarity is dead" – long live transformation: five principles for climate change adaptation law' (2010) 34 *Harvard Environmental Law Review* 9

hierarchies and cascades, non-linear change (for example, succession and collapse), ecological debt, ecological memory, niche theory, and so on, provide a rich conceptual field important to informing - and instructing – law and policy.[280]

[280] See generally the illustrative list of ecological theory in Scheiner and Willig 'A general theory of ecology' (2008) 1 *Theoretical Ecology* 21

2.3 Review of literature 3: Indigenous science and cultural knowledge

The third field of knowledge pertinent to 'environmental net gain' concepts for the Yarra Birrarung is the growing literature on Indigenous science. This field concerns Aboriginal cultural knowledge, and integration of (Cartesian) scientific knowledge systems with cultural knowledge. This literature concerns growing forms of *hybrid or pluralistic* knowledge systems. Indigenous science and cultural knowledge relate to other terms such as 'traditional ecological knowledge'. Indigenous science and pluralistic knowledge systems are important not only for the knowledge they produce and contribute to the depth and richness of understanding of the natural world, but for the diversity and rigour of intellectual sources and authorities applied to the natural world.

For the purposes of this report we will refer to 'cultural knowledge' to refer to Indigenous science and knowledge systems.

Scientific, philosophical and legal literature are coming to terms with cultural knowledge, such as through integrated forms of resource assessment,[281] legal obligations to account for Aboriginal uses and values,[282] and the 'weaving' together of scientific and cultural knowledge.[283] At a more fundamental level, knowledge 'woven' from science and culture is also an epistemological meeting space – a dialogue between different forms of knowing.[284]

2.3.1 Assumptions and perspectives of conservation science and policy

Conventional science reflects several tacit assumptions:

- 'Environment' and derivative concepts, such as conservation, ecology and restoration, treat the natural world as an assemblage (often complex) of objects. This is exemplified in the paradigms of natural 'resources' and environmental 'assets' and ecological 'systems'.

- This natural world is best known by way of science and scientific methods. More precisely, when we use the term 'science' we assume reference to Cartesian models of scientific method, which distinguishes between the (privileged and expert) 'observer' and the 'observed' (such as the natural world, in natural sciences, or societies, in social sciences) in the active process of producing knowledge.

[281] Mackenzie et al *Cultural Flows: Field Studies – Final Report* (MLDRIN, NBAN, NAILSMA, 2017), http://culturalflows.com.au/images/documents/Final%20report.pdf and other reports from Components 3-5, http://culturalflows.com.au/index.php?option=com_content&view=article&id=38&Itemid=131; Mooney and Cullen 'Implementing the Aboriginal waterway assessment tool: collaboration to engage and empower First Nations in waterway management' (2019) 26 *Australasian Journal of Environmental Management* 3 197
[282] Eg *Basin Plan 2012*, Ch 10 Part 14; *Water Act 1989* (Vic), subs 189(1)(a) (concerning waterway authority planning for inter alia Aboriginal uses and values); *Flora and Fauna Guarantee Act 1988* (Vic), subs 4A(a)
[283] Woodward et al (eds) *Our Knowledge, Our Way* (CSIRO, 2020)
[284] See eg Ann McGrath '"All things will outlast us": how the indigenous concept of deep time helps us understand environmental destruction' *The Conversation*, 19 August 2020, https://theconversation.com/all-things-will-outlast-us-how-the-indigenous-concept-of-deep-time-helps-us-understand-environmental-destruction-132201; Virginia Marshall *Overturning Aqua Nullius: Securing Aboriginal Water Rights* (AITSIS, 2017), https://aiatsis.gov.au/publications/products/overturning-aqua-nullius-securing-aboriginal-water-rights/paperback

- Law and policy orders human interactions with this natural environment by way of enforceable rights and obligations set out by (distant and abstract) legislative and executive authority.

- The objectified and legally inscribed natural world of the 'environment' and 'Yarra River land' can be described and explained by technically-trained subject-matter experts.

What is also unstated in these assumptions is that human interaction with the natural world depends on certain relationships. A key relationship is the objective and technical *management* of the natural world, exercised through scientific knowledge. An extension of this approach is that we relate to nature as 'users' or 'consumers'. This approach epitomises the 'western' and 'settler' relationships to the natural world. It is closely associated with norms of *domination* of the natural world.[285]

2.3.2 Knowledge sources and pluralistic scientific practice

Environmental and natural resources management integrates scientific knowledge and information into assessment, planning and management processes. Conventional approaches to this management presume separate domains of scientific (for example, ecological or hydrological) and cultural knowledge. The latter is often associated with cultural 'heritage', a domain influenced by archaeological origins and tending to focus on 'tangible' materials ('artefacts') and site-specific protections. 'Culture' in this context is a form of super-added domain and set of additional considerations in management. Notwithstanding a more sophisticated approach now evident in Victorian land and resource use (for example, in recognition of relational 'intangible' heritage), the prevailing approach in practice remains inclusive of Aboriginal 'cultural heritage' assessment as one of several fields of consideration in decision-making.

This approach is typified in development approval processes, where Aboriginal heritage information may be a mandatory requirement in decision-making (for example, in proximity to waterways) but one of the 'bundle' of information to be accommodated and 'balanced'. In water management, the approach to accounting for 'cultural' information has become documentation of 'uses' and 'values', often by way of 'desktop' assessments combined with in-person meetings (for example, workshops) with Traditional Owners, as an evidentiary base to inform and legitimate water planning.

In these processes, the arguable approach is treatment of Aboriginal cultural knowledge as a particular source of information (data) in the interdisciplinary scientific exercise informing decision-making. At worst, cultural knowledge is a product in passive acquisition and minor input into processes of inquiry.

Increasingly the (Cartesian) scientific method has been adapted and transformed in order to better recognise cultural knowledge as an *extension* of scientific knowledge, as well as to

[285] Hence, for example, the close association of the legal foundations of property in Anglo-Australian law with rights amounting to absolute dominion over land, as famously expressed by Blackstone in his *Commentaries on the Laws of England* (1753): 'There is nothing which so generally strikes the imagination, and engages the affections of mankind, as the right of property; or that sole and despotic dominion which one man claims and exercises over the external things of the world, in total exclusion of the right of any other individual in the universe.'

better reconcile cultural and scientific practices in order to extend and improve the scientific *method*. Extensive work undertaken in relation to water and waterways has integrated cultural knowledge into assessment processes and programs, including extending paradigms of water management to incorporate 'cultural health' into assessment frameworks and extend models of 'ecosystem services' to accommodate 'relational' foundations ('connection') based in 'cultural values'.[286] Key aspects of these approaches include framing the scientific project around social and cultural indicia parallel to biophysical indicia, reflective of Aboriginal epistemic models of 'Country', and joint (cultural-scientific) production of methodology and conduct of the scientific project.[287]

Emergence of these approaches to pluralistic science continues to progress and refine environmental management on a wider stage, such as international guidance on joint environmental impact assessment processes[288] as well as international legal obligations to observe Indigenous rights in relation to environmental and natural resources management.[289]

These practices of joint science have been accelerating across Australia.[290]

Patterns of inter-relationship, or 'pluralising', (Cartesian) scientific and cultural modes of knowledge can vary according to circumstances. For example, vitality of cultural knowledge in pluralistic practices will be influenced by historic impacts and ruptures of colonial experience, degrees of cultural resilience and revitalisation, and opportunities to undertake relevant NRM projects. Circumstance can determine the manner of 'overlap in values', as between for example highly quantified (scientific) 'variables' and 'intensely humanised' (cultural) landscapes.[291]

Knowledge systems and pluralism

These approaches to knowledge have been referred to as 'two-way science', underpinned by a premise and method of 'weaving' knowledge together.[292] The metaphor of 'woven' knowledge recognises the distinctive methodological and epistemological character of Cartesian science and cultural knowledge, including paradigmatic differences in how each knowledge system treats the object and subject of the natural world. Cartesian science, for example, tends to give nature objective expression in quantifiable, material phenomena, and Aboriginal science in 'relational', qualitative and both material and supernatural

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[286] Bark et al 'Operationalising the ecosystem services approach in water planning: a case study of Indigenous value from the Murray –Darling Basin, Australia' (2015) 11 *International Journal of Biodiversity Science, Ecosystem Services and Management* 3 239

[287] See Mackenzie et al *Cultural Flows: Field Studies – Final Report*

[288] Secretariat of the Convention on Biological Diversity *Akwe:Kon: Voluntary Guidelines for the Conduct of Cultural Environmental and Social Impact Assessments Regarding Developments Proposed to Take Place on, or Which are Likely to Impact on, Sacred Sites or on Lands and Waters Traditionally Occupied or Used by Indigenous or Local Communities* (2004), https://www.cbd.int/doc/publications/akwe-brochure-en.pdf.

[289] *UN Declaration on the Rights of Indigenous Peoples*, Articles 24, 25, 26, 27, 28, 29, 31, 32.

[290] Bohensky et al 'Integrating Indigenous ecological knowledge and science and natural resource management: perspectives from Australia' (2013) 18 *Ecology and Society* 3 20. Accruing examples often emerge on Country-by-Country basis: see eg McConachie et al 'Barapa Country through Barapa eyes: cultural mapping of Gunbower Island' (2020) 16 *Journal of Maps* 1 13; Bark et al 'Operationalising the ecosystem services approach in water planning'; Hemming, et al 'Researching on Ngarrindjeri Ruwe/Ruwar: Methodologies for Positive Transformation' (2010) 2 *Australian Aboriginal Studies* 92;

[291] Lynch et al 'Incorporating indigenous values with "Western" conservation values in sustainable biodiversity management' (2010) 17 Australasian Journal of Environmental Management 244, 250

[292] Johnson et al 'Weaving indigenous and sustainability sciences to diversify our methods' (2016) 11 *Sustainability Science* 11 1; Woodward et al (eds) *Our Knowledge, Our Way*

('spiritual'[293]) expression. The distinction can also be expressed in the objective reference points to 'nature' and to 'Country' respectively:

> Country is not only a common noun but also a proper noun. People talk about country in the same way they would talk about a person: they speak to country, sing to country, visit country, worry about country, feel sorry for country, and long for country. People say that country knows, hears, smells, takes notice, takes care, is sorry or happy. Country is not generalised or undifferentiated… country is a living entity with a yesterday, today and tomorrow, with a consciousness, and a will toward life. Because of this richness, country is home, and peace; nourishment for body, mind and spirit; heart's ease.[294]

Furthermore:

> Common to all Indigenous knowledge systems is the emphasis on knowledge coming from a specific place. It relates our people to our places and to our everyday life. The laws and acceptable practices that govern knowledge use are determined by local groups and need to be understood and negotiated at the local level…
>
> Indigenous knowledge comes from Country, from our ancestors and ancestral beings present in Country today. Our use of the term *Country* can challenge non-Indigenous people's understanding of the word. When we talk of Country, we are referring to all of those places that Traditional Owners speak for, the landscapes and the particular named sites and significant places within those landscapes. A person's Country might include land, and sea. It might include freshwater places, and/or the intertidal zone. It includes the cosmos, and the winds and clouds.
>
> We are connected to our Country in many and diverse ways. Our kinship relationships connect us as Aboriginal and Torres Strait Islander Peoples within a network of other people, plants, animals and features in the landscape. These relationships are formed through Country. Connection is maintained through our knowledge and through our actions to care for our Country. Our physical presence on Country re-produces our knowledge, including of seasonal and long term changes. We renew our relationships with Country through gathering, preparing, sharing and eating food from Country. We collect, prepare and use plants as medicines and for the creation of arts and crafts. We observe and talk with Country. We look after our sacred sites and dance, sing and hold ceremonies about the life-giving nature of Country.
>
> Caring for Country keeps our cultural life, identity, autonomy and health strong. Kinship, language and culture come together in our land and sea management activities and shape our health and well-being. We rely on our power to look after Country – if we fail in our obligations to keep our Country healthy, we believe that the health of the Traditional Owners will also fail…[295]

The relationship to Country derives *from* Country. As compared to the Cartesian scientific approach, the relationship (including cultural knowledge) is *of* Country, not *about* it.

Intellectual authority is these paradigms also has differing sources and repositories. Cartesian scientific authority rests typically with the 'expert', via procedures and institutions for knowledge acquisition (such as formal education and universities). Cultural authority lies in rights or duties to speak 'for Country' acquired via experience and intergenerational transmission of knowledge.

Commonalities to both knowledge systems include modes and systems of observing, classifying, inferring, predicting, problem-posing and –solving, and adaptation.[296]

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[293] See *Northern Territory v Griffiths and ors* [2019] HCA 7 ('Timber Creek Case')
[294] Deborah Bird Rose *Nourishing Terrains: Australian Aboriginal views of landscape and wilderness* (Australian Heritage Commission, 1996), cited in Woodward et al (eds) *Our Knowledge, Our Way*, 2
[295] Woodward et al (eds) *Our Knowledge, Our Way*, 5, 7
[296] Johnson et al 'Weaving indigenous and sustainability sciences', 5

The project of 'weaving' knowledge systems together provides pathways and opportunities to enrich science and knowledge generally, as well as posing real challenges. For example, there are points at which Cartesian and Indigenous scientific methods are substantially divergent, even incommensurable, such as epistemic models of time (linear time as against 'deep' time) and construction of authority in relation to knowledge (protocols of 'expert' and 'public' communities of knowledge in science as against initiated and controlled circulation of knowledge under Aboriginal custom and protocols). Perhaps not all material from one knowledge system and epistemic tradition can be woven with the other, but the issue is rather production of a common, 'respectful' space based on the synthesis of both. This has been referred to as 'bridging' knowledge systems,[297] which suggests to a truly synthetic approach which would be a 'transition'[298] to a knowledge system reflective and respectful of both Cartesian and Indigenous science. However such an epistemic model might unfold, it must inherently contend with *translation* of concepts, methods and practices across both traditions, as well as *recognition and respect for authorities* embedded in both traditions (including the exercise of sovereignty[299] in and through Indigenous science traditions).

Pluralism in restoration science: 'restoring' and 'healing'

Empirically, applying emerging, 'pluralistic' models of science to the task of ecological restoration is a compelling one when overlap between Aboriginal interests in managing Country and the conservation needs of Australian landscapes is considered. For example, if the fate of listed threatened species alone is considered as a focus and indicator of restoration then the extent of Aboriginal land tenure is compelling in itself: approximately 60% of Federally-listed threatened species are present on Aboriginal lands.[300]

Most landscape-scale conservation projects operating in Australia include Aboriginal communities as principal 'stakeholders' and collaborators, whether because of large cross-tenure focus (including Aboriginal land estates) or through recognition of Aboriginal interests other than legal interests in land. Conservation programs generally, at whatever scale and whether or not expressly focused on restoration paradigms, are now built with Traditional Owner collaborations as a key foundations.

In principle, it is important to recall that restoration is a *socio-ecological* process. Restoration science and practice presumes environmental improvement – that is, ecosystem recovery – is based on intentional, if also adaptive, methods and strategies of intervention. It is consistent with this paradigm that restoration strategies and agenda are cultural, whether collaborative with or led by Traditional Owner custodians. Indeed, the socio-ecological premise of restoration science is congruent with the accepted proposition of Aboriginal governance and management of their estates for millennia.

The pluralistic relationship of cultural knowledge and science is part of identifying and implementing the full base of knowledge necessary to inform properly the task of

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[297] Johnson et al 'Weaving indigenous and sustainability sciences'
[298] Ibid
[299] See eg *Uluru Statement from the Heart*: '…This sovereignty is a spiritual notion: the ancestral tie between the land, or 'mother nature', and the Aboriginal and Torres Strait Islander peoples who were born therefrom, remain attached thereto, and must one day return thither to be united with our ancestors. This link is the basis of the ownership of the soil, or better, of sovereignty. It has never been ceded or extinguished, and co-exists with the sovereignty of the Crown…'
[300] Leiper et al 'Quantifying current and potential contributions of Australian indigenous peoples to threatened species management' (2018) 32 *Conservation Biology* 5 1038

restoration.[301] Traditional Owners and cultural knowledge-holders will be part of practitioner-researcher collaborations, potentially as either or both. Indigenous science as part of the 'high degree of ecological knowledge'[302] essential to restoration practice is patently necessary.

Cultural intersections with restoration science and practice, however, may not align neatly or inevitably with values prioritised by ecological science. 'Overlap', 'weaving'[303] and 'bridging' of domains of conventional science and cultural knowledge are necessary in the task of restoration. This includes relationships and protocols of authority,[304] such as in the setting of research agenda and programs, the setting and use of terms and language in restoration projects, and the implementation of restoration programs. Exercise of authority in relation to ecological restoration can be guided by 'best practice' in respecting cultural knowledge in restoration programs. This can be informed by tools such as the recent *Our Knowledge, Our Way* report.[305] Among other lessons, 'best practice' will be informed by devices such as 'free, prior and informed consent' and agreement-making. These are specific protocols that can underpin actions and policies affecting the Yarra Birrarung, for example.

The synthesis of cultural knowledge and conventional science in restoration is not only informed by the negotiation of common practices and agenda. It also concerns the *different ways of knowing* the processes of change at issue. For ecological science, as noted, improvement concerns recovery in ecosystems and processes. For cultural knowledge, improvement concerns 'caring for Country' and *healing of Country*,[306] which is an approach consistent with the 'relational' character of land and resources. The restorative process of healing is also intrinsically linked to communities and people: it directly concerns the well-being and fate of Aboriginal communities. Healing and restoration of Country are not confined to natural systems and processes. Historical and human events, such as gatherings and ceremonies, massacres, and removals, are intimately part of healing and restoration processes. Similarly, caring for Country and the healing of Country is closely connected to social processes,[307] such as intergenerational transmission of knowledge, cross-cultural education, revival of language, art, music and dance, and access to Country. The latter issue clearly has important legal ramifications, which arise from the historic enclosure and expropriation of Aboriginal lands through colonisation. In this respect, the perspective of healing Country might be closely linked to landscape restoration across tenures, as well as to models of urban conservation and restoration.

2.3.3 Wurundjeri values and perspectives in relation to the Birrarung

Pluralistic knowledge systems are relevant to management of the Yarra Birrarung. This fact is implied in Wurundjeri custodianship of cultural knowledge and authority in relation to the Birrarung and in the bicultural character of the river as this is set out and recognised in the Yarra Birrarung Act. The model of the 'living entity' provides the vehicle for expression and exploration of the joint cultural and scientific understanding of how the river corridor should

[301] SER International Restoration Standards, Principle 3, 22-25
[302] Ibid, 22
[303] Woodward et al (eds) *Our Knowledge, Our Way*, xii, Ch 3
[304] See eg MacKenzie *Cultural Flows – Aboriginal Water Interests for Establishing Cultural Flows: Preliminary Findings* (MLDRIN, NBAN, NAILSMA, 2016), http://culturalflows.com.au/images/documents/Preliminary%20findings.pdf
[305] *Our Knowledge, Our Way*, 20
[306] See eg *Our Knowledge, Our Way*, 10-15; Wurundjeri Narrap team (pers comm, 2 October 2020)
[307] See *Our Knowledge, Our Way*, Ch 2

be managed. The scientific expression will be particularly, but not exclusively, informed by ecological and hydrological sciences.

This means that environmental 'net gain' must have cultural expression, be informed by Wurundjeri cultural determinants and indicia, and knowledge underpinning this process will aim to 'weave' cultural and scientific sources. As a starting point, this pluralistic approach to 'net gain' will recognise the Yarra Birrarung corridor as both 'environment' and 'Country'. The inference of improvement in environmental condition in the environmental 'net gain' concept indicates also the marriage of concepts such as restoration or recovery with cultural terms such as 'caring' for and 'healing' of Country.

The alignment of ecological restoration with targeted care for Country is identified, for example, in recommendations of the Bulleen-Banyule Flats Cultural Values Study, which represents a comprehensive study of the Birrarung as a Wurundjeri cultural landscape. Similarly, the preference within the Wurundjeri Narrap team to re-establish appropriate (cultural) fire regimes on Country, and to re-establish ecological (wildlife) corridors in certain parts of Country based upon the role of identified keystone species (quoll),[308] are reflective of an approach to environmental improvement bringing together cultural and ecological priorities.

Cultural knowledge and law of the Birrarung

The Birrarung is a central part of Wurundjeri Country. Wurundjeri are holders and custodians of cultural knowledge of the Birrarung. The pluralistic approach to the Birrarung is expressed in the Wurundjeri water policy document:

> The Wurundjeri believe that we need to change how all Victorians think about and actively respect the Birrarung. We believe we need to see not a resource to be exploited but rather to recognise the complex, living system that is sensitive to its surrounds and a uniquely Victorian treasure. By engaging with those partners with whom we now share the river we, together, are capable of turning around the damage of the past and acting to restore the river and its environment for the future use and enjoyment of all.
>
> Wurundjeri invites all people to see the Birrarung through our eyes, to talk with us to understand our values, and to partner with us to re-energise the river as we fulfil our cultural duty in bringing the Birrarung back to environmental, cultural, ceremonial and spiritual health.

In turn, this vision of pluralism is based on Wurundjeri knowledge and law, which is expressed in the Preamble to the Yarra Birrarung Act and in the Wurundjeri water policy:

> The Birrarung is a river of mists and shadows – the river and its environs are a living, breathing entity that follows Wurundjeri songlines and forms a central part of the Dreaming of the Wurundjeri. A Dreaming that links the billabongs, wetlands and swamps in the upstream forests, across the meandering plains and out to the salt water. We the Wurundjeri are connected to the Birrarung through spirit, culture and nature. The river follows the paths that our ancestors have travelled for thousands of years - providing for them as now it provides for all Victorians.

In the extensive study and review of the cultural values of the Birrarung, with particular attention to the Bulleen-Banyule Flats area, Freedman distils the significance and law of the Birrarung at length from historical, archaeological and anthropological sources set alongside

[308] Wurundjeri Narrap team (pers comm, Workshop, 2 October 2020)

contemporary ethnological approaches.[309] This Bulleen-Banyule Flats CVS builds on earlier and contemporaneous work, including recent cultural heritage studies in the Bulleen-Banyule area. Travers and Martin in their 2018 study of the same area set out in summary form the bases of the cultural landscape of the Birrarung in Wurundjeri law and knowledge:[310]

> The Yarra River (Birrarung) sat at the centre of the spiritual, cultural and social life of the WoiWurrung. As a site where the work of creation ancestors is revealed, as a spiritual site, as a mythological site, as a place for meeting, as a means of transport and as a source of food. The WoiWurrung's connection with the river is intimate and intricate. The Yarra River was called 'Birrarung'– the 'River of Mist' by the Kulin Nation groups who lived along its banks. The river is a spiritual focus and a confluence of songlines – see the story of how the Birrarung was created as told by Wurundjeri Elder Joy Wandin Murphy. The use of the Aboriginal name for the Yarra is an important recognition of the original inhabitants and the place names are imbued with meaning. The Maribyrnong River and the Birrarung were the major river systems in Woi wurrung Country, and their significance to Aboriginal people, who view them as arterial conduits, cannot be overstated. The spiritual connection to the water continues regardless of changes to the river's course or development along its banks – for example further down river the loss of the Yarra Falls (the basalt ledge that was dynamited in 1883 in order to make the upper Yarra navigable) has had a significant impact on the character of the river, as has the new cut in the Yarra at Fisherman's Bend (the Coode Canal), but these major impacts do not reduce the significance of the river and the spiritual connection to the water continues. In addition to the river, the Bolin Bolin Billabong is an important cultural site in the PSP. The billabong was once part of an extensive network of lagoons, vital to the life and wellbeing of the Wurundjeri for its resources and as a ceremonial and meeting place.

Freedman also cites Travers and Martin's reference to political action, overcoming disadvantage and continuing connection to the Birrarung (including key sites on the river) as important elements of cultural knowledge and law of the Birrarung.[311]

Change and continuity in cultural knowledge and law of the Birrarung

The Bulleen-Banyule Flats CVS sets out the customary law of the Birrarung as it can be ascertained pre-invasion and displacement of the Wurundjeri Woiwurrung from their estates in the nineteenth century. This survey considers comprehensively the practical, geographical, spiritual, governmental, social and cultural aspects of Wurundjeri life and the place of the Birrarung in it. It considers evidence of the traditional structure and governance of Wurundjeri society and connections to adjacent societies. It considers the Wurundjeri belief system, which, consistent with Indigenous cosmology and practice more generally, is based on landscapes deeply embedded with ancestral connections, humanised and supernatural characteristics, and relationships of authority and knowledge. The cultural landscape is a living landscape. They review key creation stories and key (totemic) entities such as Bunjil (eagle) and Waa (Crow). The Study reviews key aspects of Wurundjeri practical knowledge and use of the landscape, which retain specific currency for landscape management, such as:

- Wiowurrung seasons
- Fire management and fire regimes
- Landscape form and features (in the Heidelberg area)
- Eel fishing
- Material resource use and skilled crafts

[309] Freedman *Bulleen-Banyule Flats Cultural Values Study Report* (Wurundjeri Woiwurrung Corporation, 2020) ('Bulleen-Banyule Flats CVS')
[310] Travers and Martin *Yarra River (Birrarung) Precinct Structure Plan: Cultural Heritage Investigation – Draft Report for DELWP* (GM Heritage and Extent Heritage, 2018), cited in *Cultural Values Study*, 68-69
[311] Ibid.

- Indigenous plant and animal species (of the study area), including knowledge of their use, significance and names.

Cultural values are recorded for the Bulleen-Banyule Flats area through a combination of the ethnohistorical and archaeological record with contemporary recordings from workshops, field work, and interviews with Wurundjeri Elders. The product is a framing of cultural significance by way of multiple sources of information and knowledge. The assessment reiterates the cultural landscape[312] of the area and of the Birrarung and establishes the principal bases of cultural value of the area.[313] These cultural values also have wider currency beyond their reflection of the values for this specific area. Cultural values recorded reflect Wurundjeri continuity and connection to the Birrarung in general, including to the spectrum of relationships intrinsic to the Birrarung, and material and non-material (for example spiritual, historical and normative) expressions of that connection.

The existence of the Birrarung as a cultural landscape is an inherent characteristic of this landscape, given agency through Wurundjeri's ongoing connection, notwithstanding the impact of colonisation of that connection. The fact of the Birrarung as a cultural landscape can be understand in its latency, as well as in revival of culture. An example of this dynamic is included in a recorded statement from a Wurundjeri Elder in the Bulleen-Banyule Flats CVS:

> We never left Country. We were on Country a lot as little fella's, when our families wanted to go for a holiday or camp we all came together and camped on the Yarra Flats [Healesville c1940s- 1960s]. We used to camp up at the bush. We used to fish on the riverbanks and go swimming. Us kids never used to be frightened of jumping in the Yarra. We would swing out into the river off a rope! When the floods were in the big trees used to fall into the Yarra. The big limbs would be laying out, we would walk right out onto the Yarra on them and sit there in the sun. We were bush kids, always around the Yarra. The water starts from the Great Divide and flows all the way down to Heidelberg. It is the same river.
>
> Cultural values are the responsibility of each person to care for Country. In our traditional culture there were protocols to ensure that the resources we took from Country were not depleted. This includes the responsibility of non-Indigenous people to learn about what Country needs and advocate in the community for healthy Country. We can achieve this together through cross-cultural respect. Viewing the Yarra as a living entity will influence the community to think strategically about how it can be protected into the future. This has always been our cultural attitude to land management.
>
> To us, the cultural values are our Aboriginal values. The Narrap Team participate in water quality testing at Bolin Bolin, Banyule and Willsmere billabongs with Melbourne Water and the Victorian Environmental Water Holder. This testing helps us understand water quality prior to, and after,

[312] Bulleen-Banyule Flats CVS, 214: 'Through this approach, the landscape of the Bulleen-Banyule Flats can be understood as being physically and conceptually shaped and constructed through Wurundjeri Woiwurrung occupation, land management, social structures and belief systems. Thus, it may not be viewed as a natural landscape, but a cultural landscape, where the significance is held within the investment of meaning by the Wurundjeri Woiwurrung people.'

[313] Ibid, 225: 'These cultural values are:

- Utilisation of the Landscape
- People and Place
- Frontier Relations
- Beliefs and Customs
- The Archaeological Record
- Cultural Renewal
- Individuals Associated with the Bulleen-Banyule Flats.'

rewatering events. Audio monitoring at Willsmere Billabong has identified the rare Victorian Smooth Froglet which breeds in autumn when Country is dry. By participating in water quality testing, we learn about what water regimes different species need to thrive and what species need to be reintroduced back into these billabongs.

With our waking up of culture, we are re-establishing traditional connections. It is still ceremony, performed in today's world. The Djirri Djirri Dance Group acknowledges the six layers of Country from Tharangalk, Bunjil's Country, to the water, trees and earth. We have a creation dance about the water catchments flowing into and joining the Birrarung and then out to Port Phillip Bay. These dances are renewing traditional practises. They are relevant because we are here, we are living breathing descendants of the old people. Our dances and ceremonies are created by Wurundjeri women and we follow certain rules. We hold the Wominjeka Bubup Biik-dui (welcome baby to Country) and Murrum Turrukuruk Ceremony (women's coming of age ceremony). When children start dancing, they receive their emu feather skirt. At Murrum Turrukuruk they receive their possum pelt skirt. We hold the ceremonies on Bunjil's Country at Coranderrk in language. If you break the rules when you are representing Djirri Djirri, you have your possum skirt withheld. The reeds for the necklaces that we wear when dancing are collected when they are dry in late November and cut for the necklaces. Cultural revival brings us together.

Appendices

Appendix 1: General law and policy applying to the Yarra Birrarung

There are a range of land, natural resources, planning and environmental laws relevant to an understanding of environmental 'gain' or benefit associated with Yarra River land. In many instances, these laws are relevant to the question of environmental 'net gain' because they regulate the *use, management or status* of Yarra River land, especially its environmental character.

To use more contemporary jargon, Yarra River land is associated with a broad range of environmental, nature or ecosystem 'services' or benefits. These nature-based 'ecosystem services' are governed by a range of laws, each of which has some bearing on environmental protection or conservation.

Public lands

Key public lands legislation includes the *National Parks Act 1975* and the *Crown Land (Reserves) Act 1978*. Much of the public lands estate associated with 'Yarra River land' operates under these laws. As such, the management of public lands, such as parks and reserves, functions either predominantly for conservation purposes or, alternatively, conservation purposes are important but not exclusive reasons for the land's public tenure.

The notion of positive obligations to protect and improve the environment associated with 'gain' is not reflected in any formal scheme to offset adverse impacts or harms. In a practical conservation sense, however, concepts of 'gain' are relevant to public lands management. Under the *National Parks Act 1975*, for example, land in the national parks estate is to be managed in such a way as to protect biodiversity values as well as, proactively, to enhance those values. The conservation purposes of national parks land overall require forms of maintenance and improvement of environmental conditions. 'Gain' in this context operates in the design, planning and administration of national parks. For example, management planning for national parks must include measures to 'preserve and protect' native biodiversity and eradicate invasive species.[314]

Yarra River land governed under the *Crown Land (Reserves) Act* is public land formally managed for one or more designated public purposes.[315] Those purposes may relate to conservation, or they may be for recreational or tourism purposes, other purposes enabled by the Act, or a combination of purposes. If Crown reserves are established for conservation purposes they are generally required to be managed consistently with those purposes. There are provisions for permitting activities inconsistent with those purposes,[316] which might for example have adverse environmental impacts. No formal offsetting arrangements apply in those circumstances.

Public lands managed by Parks Victoria ('PV') are required to managed in accordance with provisions of the *Parks Victoria Act 2018* (Vic). PV is a Victoria statutory authority

[314] National Parks Act 1975 (Vic), subs 17(2)(a)
[315] *Crown Land (Reserves) Act 1978* (Vic), s 4
[316] For example, through grant of a non-conforming licence under *Crown Land (Reserves) Act 1978* (Vic), s 17B.

established under this legislation, as the main conservation agency of the State. Most Yarra River land is PV-managed land. Under the *Parks Victoria Act 2018*, Parks Victoria is obliged to manage public lands in accordance with nature conservation objectives and functions and with the intention of enabling its public land estate to be 'enjoyed and appreciated'.[317] Specifically, the objects of the agency include to 'protect, conserve and enhance Parks Victoria managed land, including its natural and cultural values, for the benefit of the environment and current and future generation'.[318] PV is governed by a statutory 'statement of obligations' and public land planning functions, which are guided by these objects.

For public lands that are part of Yarra River land specifically, governed by either national parks or Crown reserves legislation, the obligation to consider environmental 'net gain' applies to key public land managers, such as Parks Victoria,[319] the Secretary of DELWP[320] and VicRoads.[321] In this regard, these public lands represent a key *site and source* of 'gain' or benefit in the application of the 'net gain' principle arising under the Yarra Birrarung Act. In Victoria there are circumstances where public lands ('Crown land') may also form part of offsetting or 'gain' calculations for the purposes of administering the planning controls for native vegetation clearing noted above. This occurs where biodiversity 'gain' is *inferred* from:

- Transfer of land into the public estate, or
- A change in status of public land in order that conservation purposes are prioritised (where they otherwise are not), or
- Agreement-making with public land managers secure conservation outcomes.[322]

Actual biodiversity 'gain' on public is also calculated, under native vegetation guidance, through practical measures to maintain or improve the environmental condition of that land.

These measures may be relevant to Yarra River land where those public lands provide a source of 'gain' for the *specific purposes* of administering native vegetation controls under planning law.

Planning law and public use zones

As noted above, the main biodiversity offsetting scheme in Victoria (native vegetation management under planning law) in fact has limited application to Yarra River land directly because Yarra River land is almost exclusively public land. Planning law does have application to biodiversity conservation and the setting out of environmental 'gain' in other ways.

One key way in which biodiversity conservation is regulated under planning law is through the operation of zoning rules. Under Victorian Planning Provisions and planning schemes, zones are a regulatory device applying particularly to how land can be used. There are various general categories of land use zones, such as uses. These uses include,for example,

[317] *Parks Victoria Act 2018* (Vic), ss 7, 8
[318] *Parks Victoria Act 2018* (Vic), subs 7(1)(a)
[319] *Parks Victoria Act 2018* (Vic), s 10
[320] *Crown Land (Reserves) Act 1978* (Vic), s 18C; *National Parks Act 1975* (Vic), s 20A; *Forests Act 1958* (Vic), s 18B
[321] *Transport Integration Act 2010* (Vic), s 89A
[322] See DELWP *Native Vegetation Gain Scoring Manual, Version 2* (2017), 9, Appendix 3

residential, commercial, industrial or farming uses. Planning schemes set out the purposes and specific controls over uses within these zones, guidance on how decisions should be made, and categories of uses that may be permitted, are prohibited or as permitted as of right. Zones are applied to identified geographic areas.

A series of zoning rules are designed expressly for public lands. Included in this set of zones are those zones designed to protect and manage conservation values on the land to which the zones are applied. These zones are identified for example as the 'Public Conservation and Resource Zone' (PCRZ), 'Public Park and Recreation Zone' (PPRZ), or 'Special Use Zone' (SUZ). For most of Yarra river land the relevant zoning is PCRZ or PPRZ. Under the former the principal purposes of the zone are protection and conservation of 'the natural environment and natural process' and to 'assist in the public education and interpretation of the natural environment with minimal degradation of the natural environment and natural processes'.[323] PPRZ provisions are directed to public open space and recreation, alongside conservation of 'areas of significance' where appropriate as well as managing commercial uses.[324]

The majority of Yarra River land is governed under public conservation zoning presently and these measures provide an important baseline of protection for natural values and benefits. Other public zones applied to Yarra River land (especially PPRZ) can provide those protection but are generally directed to mixed uses and values in the public domain.

Water resources law

Water law encompasses rights and interests in the use, diversion or control of water 'resources'. The water resources of the Yarra River system are heavily diverted and regulated, primarily for the purposes of delivering Melbourne's water supply. A smaller proportion of diversions are for irrigation purposes in agricultural areas. Approximately 50% of water in the upper catchment of the Yarra River system is diverted for these 'consumptive' purposes.

Although the Yarra Birrarung legislation concerns a river and its environs, water resources law plays only a small or marginal direct role in river management under that law. For the most part, the Yarra Birrarung legislation concerns land and land-use. This legislation intersects with water legislation primarily through interaction with the regional Healthy Waterways Strategy prepared and implemented by Melbourne Water, the principal water and catchment management authority.
[325]

The question of environmental or conservation benefit, or 'gain', as it relates to water law and water resources management for the Yarra River arises in three ways.

[323] VPP, cl 36.03.
[324] VPP, cl 36.02
[325] It is open for actions implemented under the Yarra Birrarung legislation, such as actions in the Yarra strategic Plan, to respond directly to issue of water management to the extent the intention of the Yarra legislation is to improve the health of the *river* per se rather than solely Yarra River *land*: see eg Bruce Lindsay 'Higher and distinctive standards for urban river protection? Special purpose "river laws" and land-use planning' (2020) 37 *Environmental and Planning Law Journal* 3 338. Actions proposed under the draft Yarra Strategic Plan do include watering measures, such as environmental water management for Bolin Bolin Billabong in Bulleen.

Firstly, there is the general proposition that water resources are required to be managed 'sustainably' under the Water Act.[326] Sustainability in this context is informed by ecological sustainability and therefore concepts of environmental harm and benefit.[327]

Secondly, water authorities, including Melbourne Water as the authority principally responsible for the Yarra River, are obliged to function in such a way as to identify and plan for various values, including environmental, cultural, social and economic values.[328] More specifically, MW is obliged to design and implemented programs, plans and works to 'improve the environmental values and health of water ecosystems'.[329] In this regard, key institutional functions for river management are *presently* directed to environmental 'gain'.

Thirdly, the 'net gain' principle deriving from the Yarra Birrarung legislation is a more specific, obligatory consideration in the exercise by Melbourne Water of its powers and performance of its functions in relation to Yarra River land. That is, the identification and delivery of overall beneficial environmental outcomes is attached to all relevant MW functions and powers.

Otherwise, water resource law and policy of itself does not include a form of 'offsetting' arrangement or 'transactional' mechanism for the balancing of adverse environmental actions or practices as against beneficial actions or practices.

Environment protection law

Environment protection law in Victoria refers to laws for the control and prevention of pollution. The main statute is the *Environment Protection Act 1970*. The public authority set up to administer and regulate law under this law is the Environment Protection Authority. It is not a public authority to which the 'net gain' principle under the Yarra Birrarung Act applies. Environment protection law is referred to here in order to set out the broader context of environmental transactions or trade-offs potentially relevant to Yarra River land.

Where environment protection law presently is relevant to the question of 'net gain' for Yarra River land is in the regulation of wastewater discharges into waterways, including regulation of schemes for 'offsetting' environmental harms from discharges. In the context of the Yarra River, regulated discharges are most likely to be water releases, containing pollutants, from sewerage treatment plants in the Yarra catchment, such as at Brushy Creek. These plants and discharges from them are managed by retail water authorities, such as Yarra Valley Water. These authorities are also not public authorities to which the Yarra Protection principles apply. Other forms of wastewater discharge, such as irrigation runoff from agriculture, may be regulated under these provisions.

The regulation of wastewater discharges is intended to protect 'beneficial uses' of waters. 'Beneficial use' of waters under environmental protection law includes ecological integrity of water dependent ecosystems, recreational values, and Aboriginal cultural values, among other values. These values may traverse land and other resources such as biodiversity, as well as water. To this extent, the broad concept of 'beneficial use' of waters can overlap with the issue of environmental condition of Yarra River land. For example, physical and biological

[326] *Alanvale Pty Ltd v Southern Rural Water (Red Dot)* [2010] VCAT 480, [24]-[27]
[327] See *Alanvale Pty Ltd v Southern Rural Water (Red Dot)* [2010] VCAT 480, [151]-[154]
[328] *Water Act 1989* (Vic), subs 189(1)(a)
[329] *Water Act 1989* (Vic), subs 189(1)(bb)

features of Yarra River land inherent to the river's water-dependent ecosystems, such as riparian vegetation or billabongs, form part of the 'beneficial use' regulated under Victorian environment protection law. 'Beneficial use' in this respect overlaps with the concept of environmental 'gain'. It may be understood as a form of 'gain'. Indeed, environmental protection law sets out in detail 'beneficial uses' specific to the Yarra River for distinct sections (known as 'segment') and provides a useful point of reference for environmental 'gain' or condition as this is water-related.

For licensed wastewater discharges, as a specific activity for which offsetting is permissible, the trade-off for adverse impacts on 'beneficial uses' (such as the water-dependent ecology of Yarra River land) is to be 'a measure… undertaking works to achieve a net environment benefit'.[330] In effect, this provision under Victorian pollution regulation requires an outcome comparable to environmental 'net gain', although it is applicable only under these rules in respect of wastewater discharges.

Biodiversity law: the Flora and Fauna Guarantee Act 1988

Environmental 'gain' in the context of the Yarra Birrarung Act needs also to take into account biodiversity conservation law and policy under the *Flora and Fauna Guarantee Act 1988*. The FFG Act is Victoria's principal, stand-alone biodiversity law. Recent amendments to the Act commenced on 1 June 2020. Two aspects of the FFG Act are potentially relevant to the assessment and/or delivery of 'gain' and biodiversity conservation benefit under this legislation.

Firstly, the FFG Act includes statutory prohibitions on the harm or 'take' of protected vegetation. These protections are broad and wider than listed rare or threatened species. The prohibitions on 'take' apply effectively to public land only. The Act provides for the issuing of permits to 'take' protected vegetation, subject to the qualification that a permit must not be issued if, in the opinion of the Secretary of DELWP, to do so would 'threaten the conservation of the [species or community of which the vegetation forms a part]'. In practice, these 'flora controls' under the FFG Act are primarily used to regulate 'take' on public land for commercial purposes, such as sale, although in principle the conservation ambit of the Act is wider.

Secondly, the FFG Act now establishes biodiversity conservation obligations on public authorities across government.[331] These are general obligations which operate in addition to any specific obligations on public authorities in relation to Yarra River land (such as consideration of Yarra protection principles, including environmental 'net gain'). Public authority obligations under the FFG Act are of general application effectively in public administration. These obligations impose the requirement on public authorities to give 'proper consideration' to the objectives of the Act and the Victorian Biodiversity Strategy.[332] The objectives of the FFG Act are comprehensive biodiversity conservation objectives, including not only protection of biodiversity but also ecological restoration and recovery, the mitigation of threats, and ecologically sustainable use of biodiversity.[333] 'Strengthened'[334]

[330] SEPP (Waters), cl 6 ('offset measure')
[331] *Flora and Fauna Guarantee Act 1988* (Vic), s 4B
[332] *Flora and Fauna Guarantee Act 1988* (Vic), s 4B
[333] *Flora and Fauna Guarantee Act 1988* (Vic), s 4
[334] Parliament of Victoria *Hansard*, Hon. Lily D'Ambrosio (Minister for Energy, Environment and Climate Change), Second Reading Speech, Flora and Fauna Guarantee Bill 2019, Legislative Assembly, 2272

biodiversity conservation obligations across government in Victoria means that consideration of environmental 'gain' in respect of the Yarra River is intended to function as a specific matter within a wider re-orientation of government conduct and statutory decision- and policy-making.

Aboriginal heritage law

Aboriginal heritage law in Victoria operates under the *Aboriginal Heritage Act 2006* (Vic). The Act intends to recognise, protect and conserve Aboriginal heritage and enable Aboriginal people to act as guardians over that heritage. Aboriginal heritage broadly falls into two categories: Aboriginal heritage, comprising Aboriginal places, objects and remains[335] (largely what can be termed tangibly heritage) and Aboriginal intangible heritage, comprising knowledge, practices, rituals, traditions and so forth.[336] In effect, the original propensity to archaeological understandings of Aboriginal heritage has been supplemented by more contemporary models of heritage as 'living' practices, customs and traditions.

Protection of Aboriginal heritage functions by way of its registration under the Act and prohibitions on harm to that heritage in a manner not permitted or regulated under the Act. Analogous to resource-based legislation, there is a general prohibition on harm, disturbance, interference or various other dealings in Aboriginal heritage, which may be nonetheless permitted under section 29 and Part 3 Division 4 of the Act (cultural heritage permits) or through the operation of cultural heritage management plans under Part 4.

Aboriginal heritage agreements can be entered into in order to protect and manage Aboriginal heritage, which legal effect comparable to contracts.[337] Land management agreements can be entered into in relation to the management and protection of Aboriginal heritage in specific areas.[338]

Protection of intangible Aboriginal heritage operates principally by way of agreement-making, subsequent to intangible heritage being registered.[339]

The Act establishes machinery for administration of Aboriginal heritage including the Aboriginal Heritage Council, the Aboriginal Heritage Register, Registered Aboriginal Parties, an Aboriginal Cultural Heritage Fund, administrative orders (such as stop order to halt destruction of heritage), and enforcement powers.

In addition to specifically registered Aboriginal heritage in the Yarra Birrarung corridor, Aboriginal heritage regulations may function to protect Aboriginal heritage within 200m of the waterway. This protection can be triggered by activities that would have a high impact on the corridor. In general, areas within 200m of a waterway are deemed to be an area of cultural sensitivity.[340]

[335] *Aboriginal Heritage Act 2006* (Vic), s 4
[336] *Aboriginal Heritage Act 2006* (Vic), s 79B
[337] *Aboriginal Heritage Act 2006* (Vic), Part 5
[338] *Aboriginal Heritage Act 2006* (Vic), Part 5 Div 1A
[339] *Aboriginal Heritage Act 2006* (Vic), Part 5A
[340] *Aboriginal Heritage Regulations 2018* (Vic), reg 26

Appendix 2: Key offsetting schemes currently relevant to the Yarra Birrarung corridor

Accounting for adverse environmental impacts from human actions or conduct, such as development or works, is a well-established feature of Australia's legal and policy landscape. Requiring positive and beneficial 'counter-measures' for the environment, in response to those adverse impacts, is also a well-established legal and policy feature. The notion of environmental 'gain' in these contexts is associated with those organised counter-measures and the specific actions they require. Environmental offsets are exemplary of this model.

These arrangements typically set out processes for the assessment of environmental harm, loss or damage, establish statutory powers to approve or authorise those harms, and require the counter-measures intended to redress harm. The general model is akin to an environmental and regulatory transaction. The policy objectives those 'transaction' serve are often expressed as achievement of 'net gain' or 'no net loss' for the environment.

Planning law and biodiversity 'gain'

Planning law and 'gain' in the context of native vegetation

Victorian planning law includes an express intention that planning decisions lead to 'no net loss' of native vegetation.[341] Native vegetation is defined broadly to encompass native flora and habitat. It is an important legal and policy control on environmental loss or harm in Victoria. It has particular application to private land and hence land within the Yarra River corridor outside of Yarra River land (which is primarily public land). Regardless of these qualifications, as a framework planning controls on native vegetation clearing set up an arrangement where loss or harm from clearing is to be 'offset' by, and linked to, conservation actions representing 'gains'.

Planning decisions and native vegetation

Key planning decisions in Victoria are the making and amendment of planning schemes, which are the statutory rules and codes applying to land use and development, and the granting of planning permits. The latter are approvals for specific land uses, works or development.

Planning law applies throughout the Yarra River corridor. It regulates use, development and protection of land. A distinguishing feature of planning legislation is the nexus to *land*. In the context of rivers and waterways, such as the Yarra River, this feature is important as it precludes operation of law and policy to water, or more precisely water resources and rights to control, divert or use water.

Victorian planning law is characterised by both the form of statutory code embodied in planning schemes and a hierarchy of integrated planning rules, policies and provisions which include State standard provisions embedded in all planning schemes called Victoria Planning Provisions ('VPPs'). Planning schemes apply to geographically distinct areas, ordinarily equating to municipal boundaries.

VPPs include a State standard provision under clause 52.17 of all planning schemes governing the removal, destruction or lopping of native vegetation. In turn, this legal control

[341] Victoria Planning Provisions, cl 52.17

is informed and guided by policy on native vegetation clearing and, where cleared, conditions for 'offsetting' the losses or harm embodied in that clearing.

The objective set out in clause 52.17 is 'to ensure there is no net loss to biodiversity as a result of the removal, destruction or lopping of native vegetation'. This objective is to be achieved through implementation of the step-wise approach to decision-making prioritising avoidance of removal or harm, followed by efforts at minimisation, and finally the offsetting of biodiversity loss associated with approved native vegetation removal. On this basis, offsetting actions are intended as *residual counter-measures*, equating, in principle, to replacement or compensation for the biodiversity values lost through removal, destruction or lopping of native vegetation.

The approval of native vegetation removal is given legal form in a planning permit. This is effectively a statutory right to impact adversely on native vegetation. The offsetting measures are given legal expression as, firstly, conditions on the permit, or in other words statutory obligations to secure those counter-measures in order to obtain approval, and, secondly, as legal controls and positive obligations for biodiversity protection and conservation on other land where these positive counter-measures are to be implemented (an offset site). The offset site may be on land owned by the permit-holder (first party offset) or land owned by another landowner (third party offset).

In these respects, native vegetation removal and offsetting in Victoria functions in a similar manner to other biodiversity offsetting schemes.

The overall biodiversity outcome under these policy settings is intended to be 'no net loss', or a form of calculated neutrality on biodiversity outcomes. These settings are detailed in *Guidelines for the Removal, Destruction or Lopping of Native Vegetation*, a document incorporated into all planning schemes.

'Biodiversity value' and 'gain'

The native vegetation clearing scheme in Victoria sets up a nexus between individual actions adversely impacting on biodiversity and actions intended to protect and conserve biodiversity. This nexus is based upon a deemed or inferred equivalence in 'biodiversity value' between habitat lost or harmed and habitat conserved. The latter is intended to be compensatory. 'Biodiversity value' is a technical and policy construct (a model), based on a set of ecological and biological characteristics applied to all native vegetation, used to quantify the functions and benefits of native vegetation. In this manner, the 'biodiversity value' of native vegetation in Victoria can be reduced to a 'score', or composite of 'scores'.

The key ecological and biological characteristics of native vegetation considered in this scoring system include:

- Biological condition ('habitat hectares')
- Landscape connectivity ('strategic biodiversity value')
- Habitat for rare or threatened species ('Habitat importance')

Other characteristic may be relevant, such as important wetlands or coastal areas. Each is calculated either by an accredited specialist ('assessor') or by way of digital modelling or a combination of the two.

Baselines for ecological condition or value of native vegetation inform assessment and modelling processes. The relevant scientific baselines include the inferred state of native vegetation and biodiversity prior to European colonisation (Ecological Vegetation Class benchmarks, or EVCs), wetland significance against a known database, and habitat connectivity at landscape scales.[342]

This scoring system enables correlation of an inferred value of native vegetation to be lost or harmed to vegetation to be conserved ('offset').

The latter (native vegetation to be conserved) informs the concept of 'gain'. Environmental 'gain' under this system includes protection and preservation of native vegetation of a certain biodiversity value, combined with measures directed to assurance of conservation outcomes, including legal security of offset land for conservation purposes and requirement that maintenance and improvement in the quality of native vegetation is in addition to what the law would compel in any case. This native vegetation scheme therefore deems certain forms of action to be 'gains', such as legal protection of habitat (such as via conservation covenants) and improvement to environmental condition over a 10-year period. This model of biodiversity 'gain' is informed by elaborate technical guidance.[343]

The policy framework set under the Guidelines creates certain additional qualifications or controls over the nexus (transaction) between native vegetation removal and offsetting as part of this *deemed equivalence* between individual harm and counter-measures. For example, beyond a certain threshold, 'gain' for the loss of rare or threatened species habitat must include conservation of habitat for the *same* species. Where such impacts on rare or threatened species are not at issue, deemed environmental 'gain' is much more loosely applied. For example, compensation for clearing of a specific ecological community, if not including rare or threatened species, need not include conservation actions or protection for that same community.[344]

Native vegetation offsetting a form of transactional 'gain'

In summary, 'net gain' as applying currently in the Yarra River corridor under planning law operates as an extension of a conventional biodiversity offsetting scheme. It functions by way of a regulated transaction between permitted environmental loss (clearing of native vegetation) and a codified set of conservation actions. Actions deemed to equate to environmental 'gain' under this scheme are confined to 'offsetting' actions permitted under policy guidance. Design of projects, developments or land uses directly do not form part of 'gain' calculation or considerations under planning law.

Federal environmental law and 'net gain'

EPBC Act and Offsets Policy

The principal Commonwealth law concerning the environment and biodiversity conservation is the Environment Protection and Biodiversity Conservation Act 1999 (Cth). This law

[342] See DELWP *Biodiversity Information Explanatory Document: Measuring Value when Removing or Offsetting Native Vegetation* (2017), https://www.environment.vic.gov.au/__data/assets/pdf_file/0025/91267/Biodiversity-information-explanatory-document-Measuring-value-when-removing-or-.pdf

[343] DELWP *Native Vegetation Gain Scoring Manual, Version 2* (2017)

[344] The offsetting in this example is confined primarily by a loose geographic proximity – that is, to offsetting within the same catchment management authority region.

applies to a limited set of matters (Matters of National Environmental Significance, or MNES), such as the protection of listed threatened species, internationally important wetlands, and fauna protected by international treaties. The EPBC Act prohibits actions having a significant adverse impact on these matters unless approved under Part 3 of the Act. Approvals are made by the Federal Environment Minister, ordinarily following an assessment process, and they may be made with conditions. Those conditions typically include obligations to offset impacts and those offset arrangements are made in accordance with the EPBC Act Offsets Policy and guidance.[345] It is under this Offsets Policy (and its operation through approvals) that rules and obligations analogous to environmental 'net gain' function in Federal environmental law.

For the Yarra River corridor, environmental matters protected under the EPBC Act mainly relate to listed threatened species. Requirements for their protection traverse public and private land.

Offsets policy and 'maintain or improve' standard

In general, the EPBC Act offsets policy provides for a comparable approach to the 'offsetting' of adverse or harmful impacts to biodiversity (or other MNES) as biodiversity offset schemes elsewhere. EPBC Act offset arrangements are intended to apply once consideration of avoidance and minimisation of impacts are exhausted. At that point, offset arrangements are compensatory for the 'residual adverse impacts of an action on the environment'.[346] The EPBC Act model implements a form of 'transaction' also, by which a 'net' outcome is intended to be achieved through 'compensatory' counter-measures required in response to approved or permitted harmful impacts. The Policy expressly includes, in guidance, a 'balance sheet approach'.[347] Those counter-measures have legal effect through enforceable conditions on the statutory approval. The Policy refers to offsets as 'environmental benefits to counter-balance' adverse impacts.[348]

In principle, the EPBC Act Offset Policy establishes a standard of environmental management including 'net gain' in relation to MNES. More precisely, the Policy requires in principle achievement of 'an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environmental law and affected by the proposed action'.[349] The minimum standard equates to 'no net loss' ('maintain') and the alternative standard includes 'net gain' ('improve').

The nature of 'gain' under the EPBC Act Offsets Policy

Two important distinguishing factors can be identified under the EPBC Act Offsets Policy. First, most but not all of the 'package' of beneficial measures intended to compensate for harmful impacts, or implement conservation 'gain' for a MNES are to be 'direct offsets', or in other words measures that comprise 'tangible and measurable on-ground conservation

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[345] Department of Sustainability, Environment, Water, Population and Communities *Environment Protection and Biodiversity Conservation Act 1999: Environmental Offsets Policy* (2012), https://www.environment.gov.au/system/files/resources/12630bb4-2c10-4c8e-815f-2d7862bf87e7/files/offsets-policy_2.pdf ('EPBC Act Offsets Policy'); *Offsets Assessment Guide*; *How to Use the Offsets Assessments Guide*, https://www.environment.gov.au/system/files/resources/12630bb4-2c10-4c8e-815f-2d7862bf87e7/files/offsets-how-use.pdf

[346] EPBC Act Offsets Policy, 4

[347] EPBC Act Offsets Policy, 4

[348] EPBC Act Offsets Policy, 7

[349] EPBC Act Offsets Policy, 6

gain'.[350] A proportion (at least 10%) of the relevant 'package' of measures may be 'indirect' offsets that are 'anticipated to lead to benefits' for the MNES affected.[351] These may include research funding for example.

Secondly, other than 'indirect' offset measures, the actions comprising EPBC Act offsets must, in effect, provide a form of 'like for like' compensation for the MNES affected: 'Offsets should be tailored specifically to the attribute of the protected matter that is impacted in order to deliver a conservation gain.' For the Yarra River corridor, for instance, where affected 'matters' are likely to include habitat for listed threatened species, 'gain' would need to demonstrate conservation benefits and outcomes to meet the habitat quality of that lost and account for key ecological processes (such as breeding and reproduction).[352] Offset arrangements must include considerations of risk, apply robust science, and adopt adequate governance.[353]

[350] EPBC Act Offsets Policy, 8, 16
[351] EPBC Act Offsets Policy, 9
[352] EPBC Act Offsets Policy, 17, EPBC Act Offsets Guide
[353] EPBC Act Offsets Policy, 23-24