Economic benefits of the Yarra River

Report to Melbourne Water

April 2018

NCEconomics

Executive summary

The Yarra River is an iconic natural asset to many Victorians, providing a wide range of benefits. Improving the understanding of the economic value of these benefits will assist decision makers improve long-term management of the Yarra and its surrounding land use.

This report summarises our findings from a desktop study to identify, scope and (where possible), estimate the economic value of the Yarra River. An ecosystem services framework is adopted covering benefits derived direct and indirectly from the use of the Yarra, and related benefits for an area up to 1km either side of the Yarra. Key findings include:

- It is estimated that the annual benefits are around $730 million. However, given the inherent variability and uncertainty in the data sources we have used, the range of our estimates is between $420 to $1,050 million.
- The economic values are largely driven by non-marketed observed and stated cultural values which require non-market valuation approaches to estimate.
- The benefits are influenced by land use around the river. For example, there are large aesthetic and recreational benefits in urban areas where the waterway and its surrounds is used for recreational and residential purposes. These benefits are reflected by willingness of people to access recreation and to be located to more natural environment.
- In the upper reaches, the riparian zones of the Yarra play an important role in reducing sediment and nutrients load runoff into the river and eventually Port Phillip Bay.

Policy implications and future work

While the current estimates should be treated as indicative only, they do demonstrate the economic and social importance of good management of the Yarra for current and future generations. Improvements to the Yarra's condition will have positive economic benefits, while allowing the Yarra to decline will result in economic costs.

Furthermore, there are significant insights to be gained by undertaking Yarra-specific biophysical and economic analyses, such as enhancing the efficiency of interventions (policies, plans, investments) under the Yarra Strategic Plan.

The major shortfalls in the quality of our economic analysis relate to the reliance on estimates from studies undertaken elsewhere to derive some of the key unit estimates, particularly recreation, and the impact on the Yarra's condition on land values reflecting underlying aesthetic and amenity values.

Aesthetic and amenity values are significant and could be enhanced through the application of a robust hedonic study to properly estimate the 'uplift' in land value reflecting access to and the condition of the Yarra to local residents. This would also inform any future cost sharing arrangements for initiatives across the Yarra Strategic Plan and its partners.

Contents

Citation:
Natural Capital Economics (2018). Economic benefits of the Yarra River, Report to Melbourne Water

Context

Context

Policy and planning context

The Yarra catchment covers an area of over 4,000 km^2 across three sub-catchments (Upper, Middle and Lower) and is home to more than one-third of Victoria's population and native plant and animal species. Land use varies throughout the catchment from protected forests and rural areas to urban development and established industry.

Importantly the catchment's waterways are a critical natural asset that provide a broad suite of benefits to the community and businesses in the region, including: water supplies for potable and agricultural uses, waterways as key locations for recreation and sources of amenity, and as important protected areas to enable native flora and fauna to thrive.

The Yarra River Action Plan (YRAP) identifies Melbourne Water as the lead agency for delivery of seven key actions, including the development of the Yarra Strategic Plan (YSP) and Community Vision. This will encompass the best available scientific information and analysis and reflect the community's long-term vision and objectives for the Yarra. The YSP has a 50-year time focus and will underpin future planning and interventions for the river corridor and each of its reaches.

The stated key elements of the YSP are:

1. The environmental health of the river (waterway and riparian land).
2. Community use, access and amenity of the river and parklands.
3. The river's landscape setting and interface of the river corridor with adjacent land use.
4. Cultural and heritage values.

Figure 1: The Yarra River

Context

Catchment extent

The specific boundaries for the YSP are articulated in the Yarra River Protection (Wilip-gin Birrarung murron) Act 2017 and includes:

- Yarra River Land (within 500 metres of the bank that is crown or freehold land owned by a responsible public entity other than a municipal council).
- Land within one kilometre of a bank of the Yarra River (other than land within the port of Melbourne and land within a special water supply catchment area.
- Other land outside the one-kilometre corridor may be included (in line with requirements laid out in the Bill).

Focus of this report

The focus on this desktop study is to rapidly review available economic and social science literature and data relating to the Yarra River, primarily focussing on the waterway and the immediate surrounds.

This desktop study covers economic values attributable to:

- Waterway and riparian health.
- Recreational and amenity values.
- Cultural and heritage values.
- Landscape attributes and values.

Benefits of the Yarra River





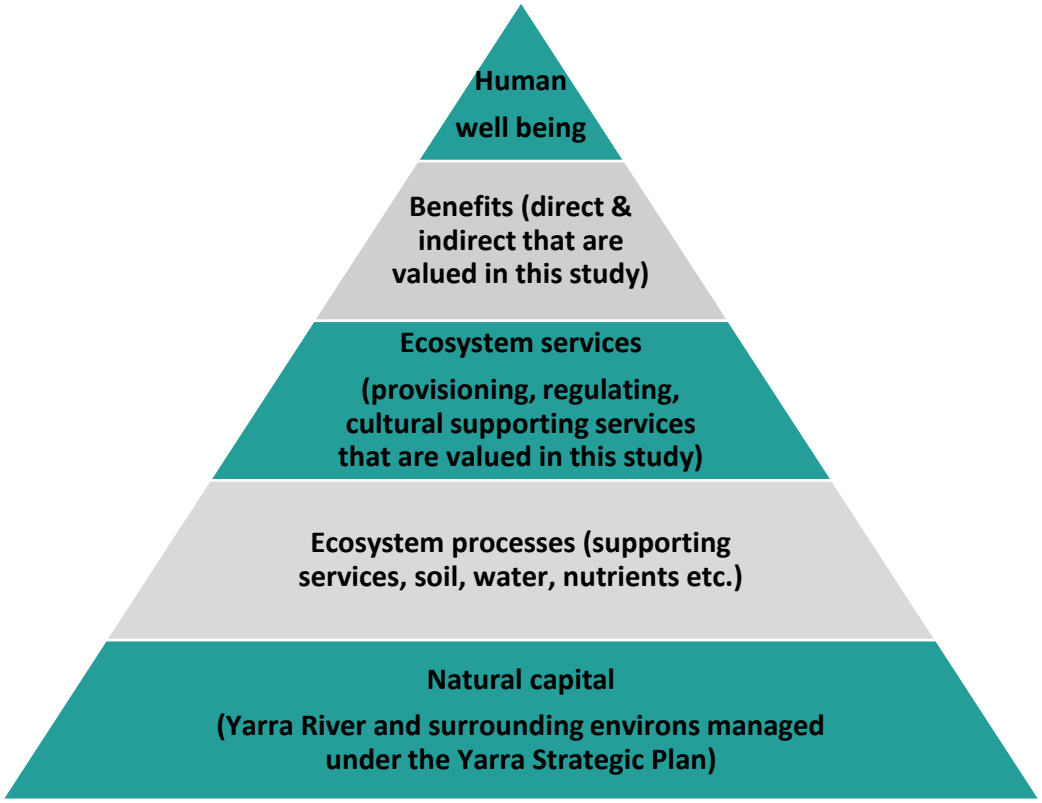
Framework and approach

Framework and approach

Ecosystem services as an underpinning framework

This project recognises that human wellbeing is highly dependent on the benefits that are derived from our natural capital – in this case the Yarra River and the adjacent land. The broad relationship between the Yarra River's natural capital and human wellbeing is shown in Figure 2 below.

Figure 2: Natural capital and human well-being



This study identifies, scopes, and (where possible) estimates the economic values of the benefits of the waterways and riparian values to stakeholders (communities and businesses). To link the natural capital of the Yarra River to economic values, an ecosystem services approach is adopted. Ecosystem services are the benefits people obtain from the natural environment. These ecosystem services are often categorised into four types, specifically:

- *Provisioning services:* consist of all the products obtained from ecosystems (e.g. raw water supplies).
- *Regulating services:* the benefits obtained from the regulation of ecosystem processes such as healthy catchments maintaining water quality.
- *Cultural services:* related to non-material benefits, for instance recreational/tourism, aesthetic cognitive and spiritual benefits.
- *Supporting services:* supporting ecosystem services that underpin the other ecosystem services categories (provisioning, regulating and cultural).

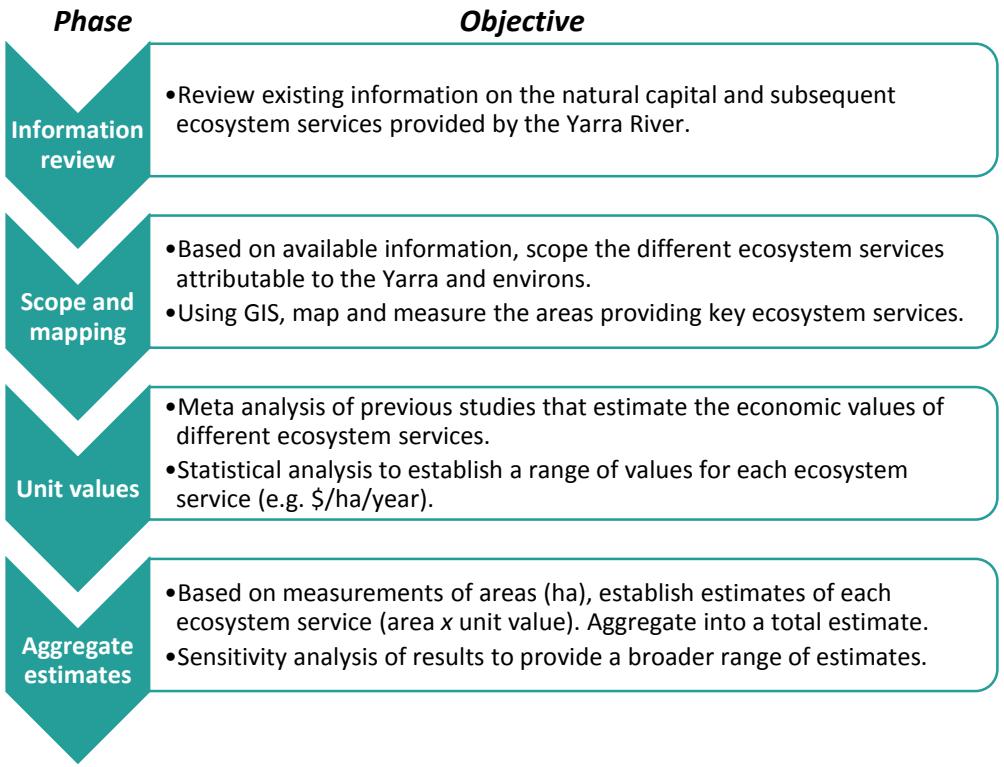
Ecosystem service valuation provides a framework through which an evaluation of the economic benefits for ecosystems can be undertaken. These benefits can then be used to compare the advantages and disadvantages of a given decision that can be used to influence socio-economic development discourse and decision making. For example, what ecosystem services would be lost if riparian condition declines?

Approach

Given the desktop nature of this study, the broad process to estimate the value of ecosystem services attributable to the Yarra has been through four specific phases. These are shown in Figure 3.

Framework and approach

Figure 3: Approach to valuation



Through the use of this approach, approximate estimates of the benefits of the Yarra River can be established, and the uncertainty of the estimates be better understood. The analysis has also identified significant gaps in knowledge.

As there are a number of different types of ecosystem services attributable to the Yarra River, a number of different types of economic valuation methodologies are required. This is particularly the case as many values attributable to the Yarra are not traded in markets and therefore do not have an observable market price. Table 1 below outlines some of the key valuation techniques used on for valuation in this study.

Table 1: Economic valuation techniques

Method	Based on…	Example uses…
Benefit transfer	Studies undertaken in similar locations	Meta analysis of previous studies undertaken elsewhere, where values are inferred on the attributes being valued in the study area
Market approaches		
Market values	Actual market transactions	Where there are established markets (e.g. carbon market)
Productivity-based	Inputs to production of commercial goods	Changes in irrigation productivity for any market gardens adjacent to waterways
Replacement cost	Costs of replacing a service or avoiding costs	Cost of water supply services attributable to changes in water quality such as avoided WSUD costs elsewhere
Non-market approaches*		
Hedonic pricing	Values of goods traded in related markets (e.g. housing)	The recreational and aesthetic value of improvements in riparian condition
Travel cost	Costs incurred in visiting a site	Valuing tourism, recreation, or cultural use of a site
Stated preference	Surveys and community willingness to pay to protect an asset	The value of the existence of biodiversity and ecosystem functions

* Prior studies were used to estimate non-market values for the Yarra River. Primary studies were outside the scope of this project

Ecosystem services

Identification, scoping and mapping

Identifying and scoping ecosystem services

Identifying and scoping ecosystem services

Ecosystem services come in many forms. We have reviewed the key literature and identified a number of key ecosystem services attributable to the Yarra River. These are briefly outlined below where we have tied the ecosystem services back to the type of natural capital (water or land), and also identified the direct and indirect beneficiaries. Note that often the same natural capital item can provide multiple benefits and that this coverage is not exhaustive.

Figure 4: Key ecosystem services identified

Natural capital	*Ecosystem services*	*Beneficiaries*
Water body	Consumptive water supply (provisioning)	Utilities, farmers, businesses, households
Water body	Non-consumptive water use (cultural) Non-consumptive water use (supporting)	Recreators, local households Aquatic habitat, fauna (e.g. fish breeding), community, consumers
Riparian zone	Water purification (freshwater and marine), cooling (regulating) Recreation & cultural	Local households, community and consumers (e.g. fish)
Green space	Recreation, aesthetic (cultural) Potential flood risk mitigation (regulatory)	Recreators, local households Insurers, asset owners, insurance consumers
Residential land	Recreation, aesthetic (cultural)	Local households, local governments (rates)
Farming land	Water used in production (provisioning)	Farmers, consumers

Mapped areas of natural capital that provide ecosystem services

Mapping natural capital

The ecosystem services ultimately relate back to the extent and condition of the natural capital from which they are derived. Based on GIS data provided by Melbourne Water and the Victorian Government, we have overlayed key natural capital assets, specifically land uses, within 1 km from the Yarra River.

Aggregation to develop estimates of ecosystem services

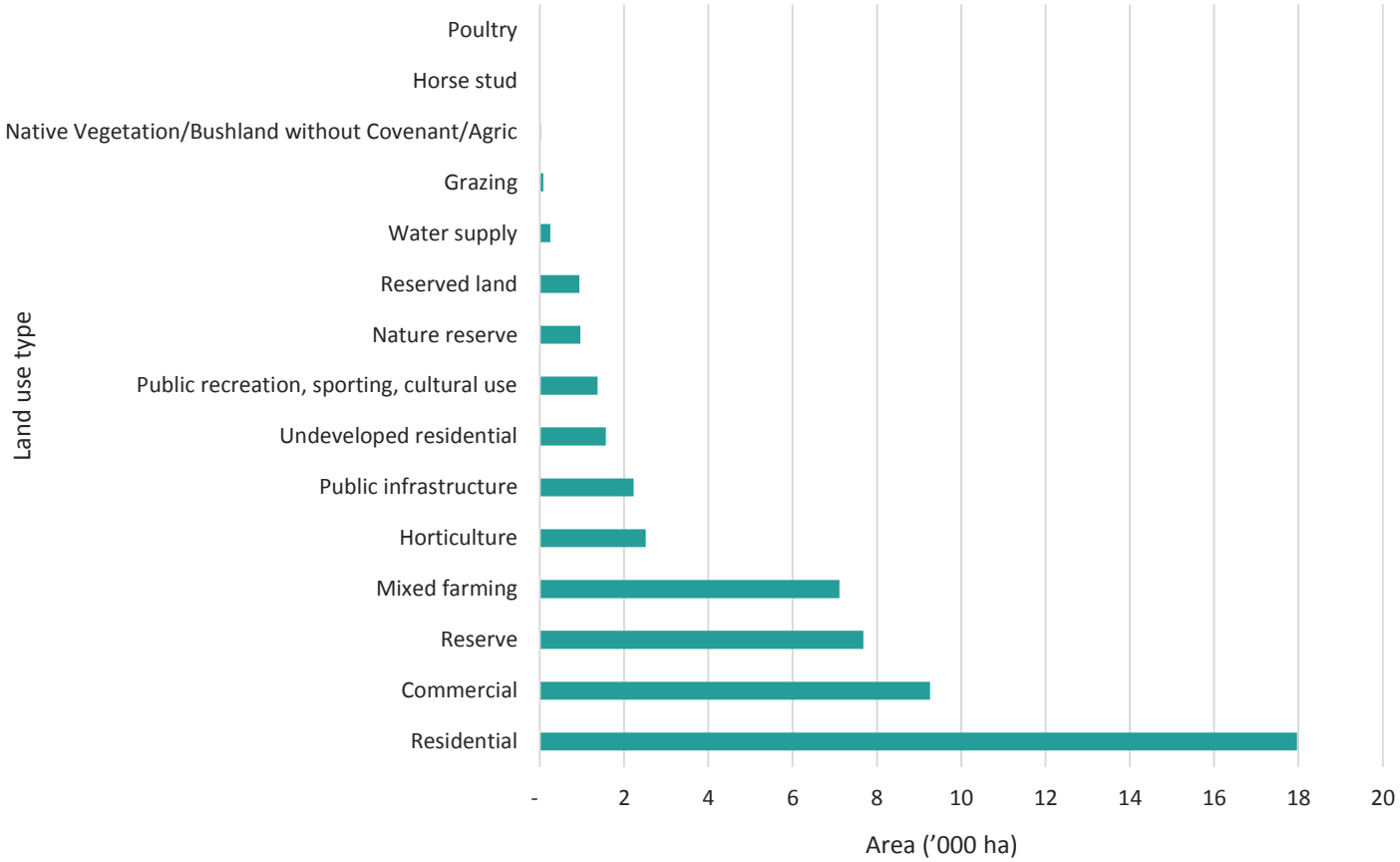
We then used data on the extent of natural capital and the unit economic estimates of benefits in the next section of this report to estimate aggregate ecosystem service values – the economic benefits of the Yarra.

For benefits that are not spatial (e.g. water consumption), other relevant metrics were used to aggregate the unit estimates.

A key point to note is the multiple levels of ownership, responsibilities and use of the natural capital that provide ecosystem services.

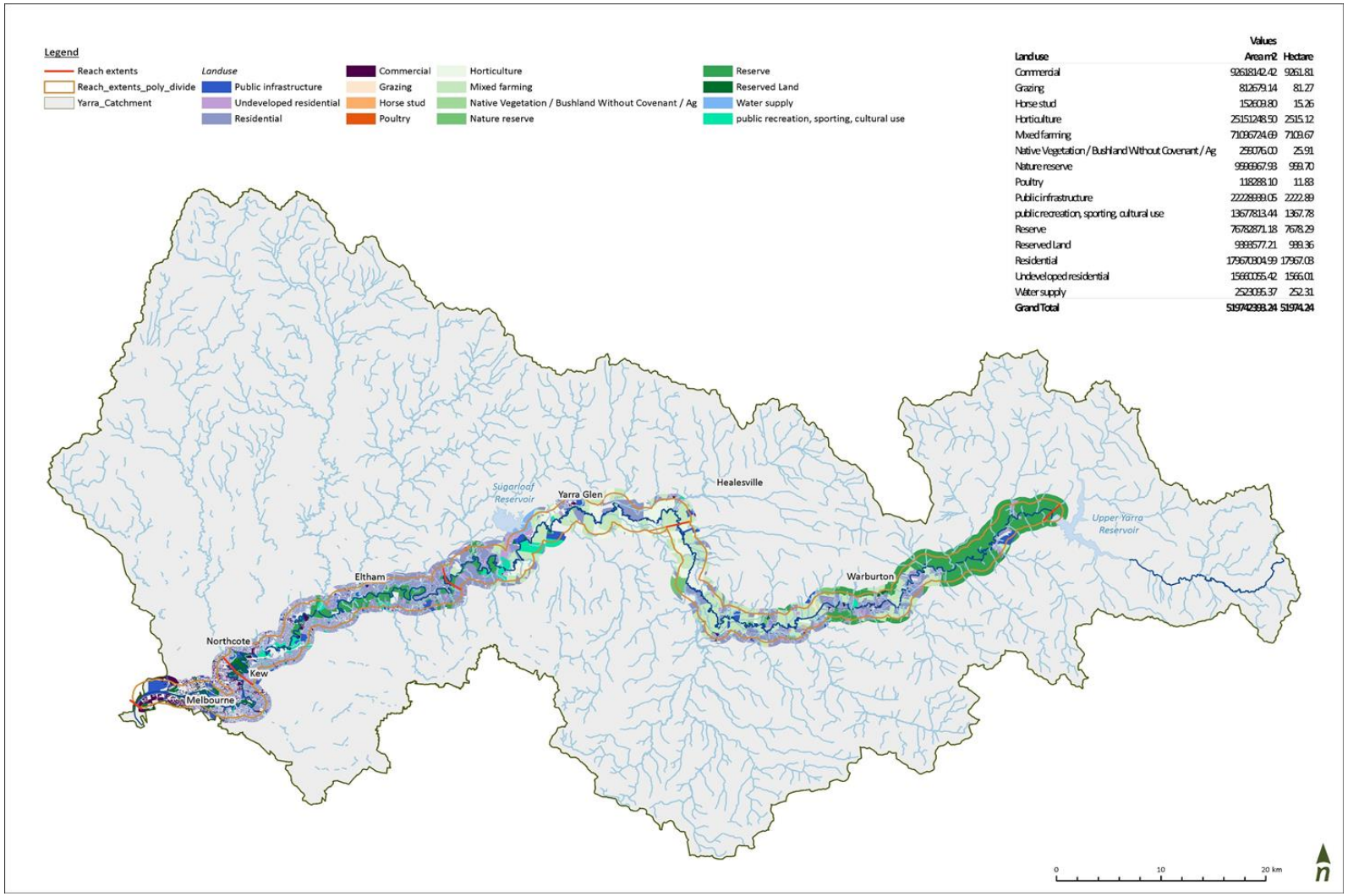
Figure 5 and 6 shows the different land uses providing ecosystem services along a 1 km buffer of the Yarra river.

Figure 5: Land uses along a 1 km buffer of the Yarra (in ha)



The Yarra

Figure 6: Key land uses providing ecosystem services within 1 km from the Yarra River



Land use	Values Area m2	Hectare
Commercial	92618142.42	9261.81
Grazing	812679.14	81.27
Horse stud	152609.80	15.26
Horticulture	25151248.50	2515.12
Mixed farming	71096724.69	7109.67
Native Vegetation / Bushland Without Covenant / Ag	259076.00	25.91
Nature reserve	9998967.93	999.70
Poultry	118288.10	11.83
Public infrastructure	22228939.05	2222.89
public recreation, sporting, cultural use	13677813.44	1367.78
Reserve	76782871.18	7678.29
Reserved Land	9938577.21	993.86
Residential	179670804.99	17967.08
Undeveloped residential	15661055.42	1566.01
Water supply	2523095.37	252.31
Grand Total	**519742393.24**	**51974.24**

Ecosystem services

Economic unit values

Economic unit values of ecosystem services

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Approach

Ultimately a benefit transfer approach is predominantly being used to establish most of the unit estimates used in this study. These have been sourced from several different previous studies. In addition, some relatively simple productivity based and replacement cost approaches are also used in our analysis. Tables 2 to 4 summarise the unit values of key ecosystem services where we have been able to source some data.

Cultural ecosystem services

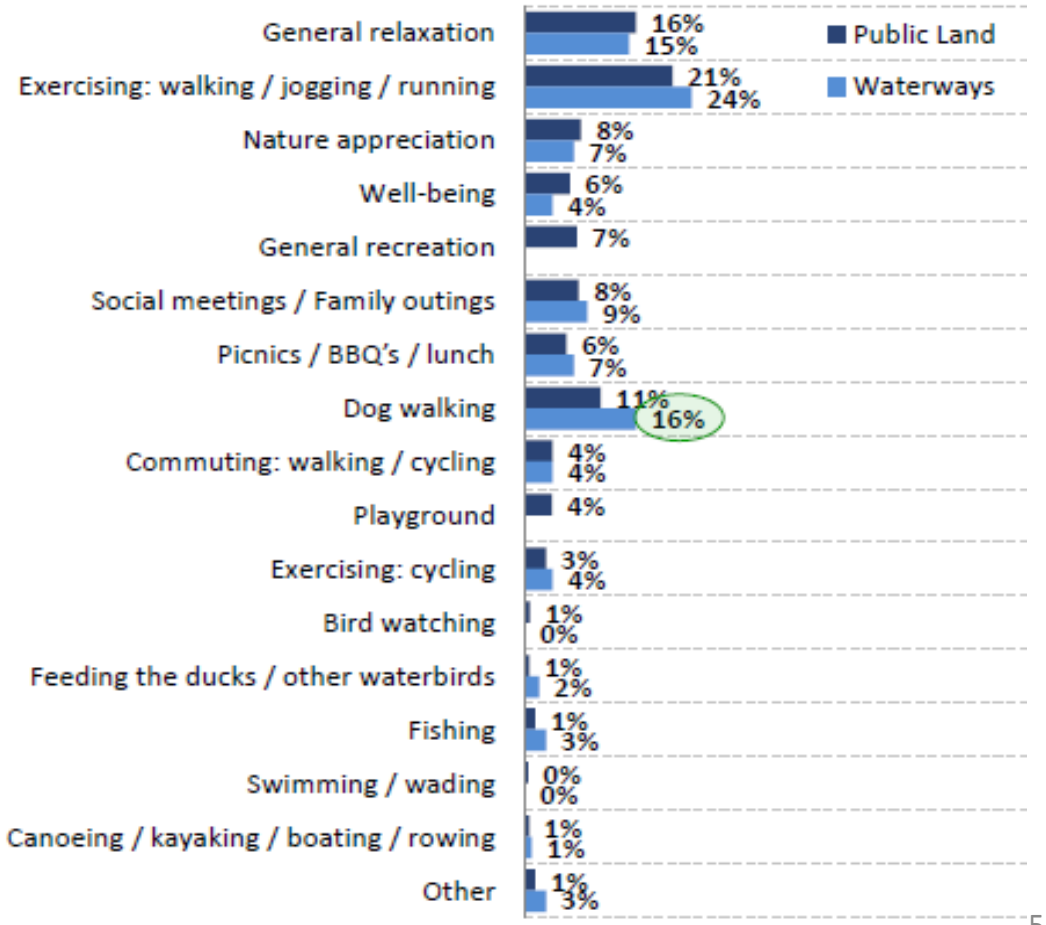
Table 2: Cultural ecosystem services

Ecosystem Service	Valuation technique	Attribute of interest	Values	Source/s
Aesthetic	Hedonic property valuation	Riparian vegetation and Channel condition	5.6% gains in property prices (range=1.13% to 9.31%)	Thomy et al. (2017) Polyakov et al. (2016)
Recreation	Travel cost method	Picnicking/BBQ and fishing	$62 per adult picnic trip (range=$49 – $87) $85 per adult fishing trip (range=$60 - $110)	Pascoe et al. (2014) Marsden Jacobs (2013)
Recreation	DALY	Walking along waterways and Cycling	$1.90 per km for walking and $1.26 per km cycling	SKM and PwC (2011)
Recreation	Travel cost method	General park recreation	$9 to $32 per visit	Parks Victoria and DELWP (2015)

It is important to note that none of the studies were undertaken specifically in the Yarra. Rather these studies have been undertaken elsewhere (e.g. South East Queensland and southern Sydney) and we have to infer these values in the Yarra. For that reason, we have estimated the likely range of values for inclusion within any aggregate estimates.

It is also important to note that the scope of recreational activities that have actually been valued in previous economic studies is narrower than actual activities undertaken in the Yarra (Figure 7).

Figure 7: Visitation activities



Economic unit values of ecosystem services

Regulating ecosystem services

Economic studies relating to regulating ecosystem services largely relate to water quality and the impact on water services provision and safety. These are shown in the table below.

Table 3: Regulation ecosystem services

Ecosystem Service	Valuation technique	Attribute of interest	Values	Source/s
Water quality	Study on efficiency performance for nutrient load reduction between a 10 m with regenerating grass and Eucalyptus globulus buffer.	Riparian buffer (10 m wide)	50-60% total load reduction for TP, TN, TSS for regenerating grass 10-40% total load reduction for TP, TN, TSS for Eucalyptus globulus	McKergow et al. (2006)
Water quality	Dam water vs desalination treatment cost	Costs avoided	$3.10/kL (range=$0.90 to $4.10/kL)	Based on estimates from WSAA.

There are a number of very important regulating ecosystem services that have not been valued by economists in a format suitable for use in this study. These include:

- The value of flood risk mitigation. This would require a major physical and economic study.
- The value of any impacts on local climate. This would require a specific study to expand the biophysical understanding to include economic benefits (e.g. avoided usage of energy on cooling homes).
- The impacts of any changes in water quality on the ecosystems services provided in Port Phillip Bay. This would include a full suite of ecosystem services from the Bay that are partially reliant on the quality of water discharges from the Yarra.

The limited scope of valuations available to draw upon for this study means any aggregate estimates developed should be treated as underestimates.

Provisioning ecosystem services

The two major provisioning ecosystems services relate to the provision of potable water for households and businesses, and the availability of non-treated water for irrigation.

Table 4: Provisioning ecosystem services

Ecosystem Service	Valuation technique	Attribute of interest	Values	Source/s
Water storage	Marginal value of stored water	Additional water	Storage @ capacity = $0/ML Storage @ 75-80% = $400/ML Storage @ 60-65 =$1,000/ML	Western et al. (2017)
Potable water supply	Avoided costs of manufactured water	Additional water	$3,420/ML	Melbourne Water (2016)
Water for irrigation	Production function	Increase in yield	$8,045/ha (range $7,480 - $8,610)	Based on Measham et al. (2013)

Insights for Yarra River Action Plan

Analysis of the Waterway Perceptions Survey and Water quality benefits for Port Philip Bay

Waterways perceptions survey

Melbourne Water regularly undertakes surveys on the community perceptions and use of waterways under its management. The visitations types from the survey were analysed and used to estimate the recreation use economic benefits. Some highlights from past surveys are outlined below.

The main stem of the Yarra river is the most frequently visited waterway in Greater Melbourne area. Survey results indicate that the majority (64%) of respondents say that waterways are extremely important for making Melbourne a place people want to live, communities flourish and businesses choose to invest.

The majority of people visit the Yarra for walking, general relation, nature appreciation, well-being and picnicking/barbeques and social/family outings (see table 7).

It is likely, that a survey of people visiting the upper reaches of the Yarra will have different values to reflect the ecosystem services offered by those reaches (e.g. more fishing, camping and boating and less exercising activities).

Frequency of monthly visits to the waterway varied by suburb housing density, people in low density suburbs visited the waterway 2.8 times a month, compared to 3.8 for medium and 4.0 for high density suburbs.

People in the medium and high density areas visit their waterways more frequently than those in low density areas.

In high density suburbs a relatively high proportion of the people (22%) reported using the waterway for commuting compared to 12% for people in low density areas. This difference is also a function of location of the high and low density areas, those closer to the CBD (higher density) can more easily walk or cycle to work.

Table 7: Reported reasons for visiting the Yarra (n=504)

Recreational activity	All reasons	Main reasons
Exercising (walking, jogging, running)	60%	27%
General relaxation	48%	14%
Nature appreciation	40%	7%
Well-being	33%	3%
Picnics/barbeque/lunch	33%	5%
Social meetings/family outings	30%	9%
Dog walking	26%	14%
Cafes/restaurants	24%	4%
Commuting (walking, cycling)	17%	5%
Exercising (cycling)	15%	4%
Feeding the ducks and other waterbirds	12%	1%
Bird watching	9%	1%
Fishing	8%	2%
Swimming/wading	6%	1%
Canoeing, kayaking, boating, rowing	4%	1%
Other	4%	27%

Aggregated economic values

Aggregate estimates

Unit values from Tables 2 to 4 were linked to land use data, median house prices, visitation activities and number of annual visits to aggregate benefits for ecosystem services for which data was available.

The estimated aggregate economic benefit is not comprehensive of all benefits derived from the Yarra River. The estimation process relied on transferring benefits from previous studies that were done for similar types of natural capital. Consequently, this is an indicative estimate only.

It is estimated that the Yarra River ecosystem services have an economic value ranging from $426 million to $1 billion.

Table 6 shows the ecosystem services and their quantified benefits.

Tables 5 shows a simple 'traffic light' approach to reflect the confidence rating of our assumptions given the available data and valuation approach used.

Table 5: Confidence rating for our estimates

	We are reasonably confident in our estimates
	We are somewhat confident in our estimates
	Treat estimates with extreme care

Table 6: Aggregated annual economic values of the Yarra ($ million)

Ecosystem Service		Conservative	Base	Optimistic	Reliability of estimates
Cultural	Recreation	356	439	603	
	Aesthetics	51	251	418	
Regulating	Carbon market	0.3	0.6	1.0	
	Avoided desalination costs*	<1.0	<1.0	<1.0	
Provisioning	Diverted water	16	21	27	
	Horticultural use	3	3	4	
Total ($ mil.)		**$ 426**	**$ 716**	**$ 1,052**	

*Does not include comparison of capital costs

Aggregate estimates

The indicative results show that cultural ecosystem services provide the highest economic values. These aesthetic and recreation values were derived using a benefit transfer approach.

Recreation economic value estimates were based types of recreational activities, the frequency of visits per year as per the Water Perceptions Survey and the unit values were based on previous studies as per Table 2.

Aesthetics values were calculated using a benefit transfer approach using a previous hedonic pricing study on detached homes from southern Sydney (Thomy et al. 2016). The number of detached houses within 1km was sourced via GIS analysis. Median house prices per postcode were then used to estimate the value of the houses and a 5% rate was used to convert the property values to proxy annualised values (as per Mazzotta et al. 2014). In Victoria the Net Annual Value is either 5% of the capital improved value or the current value of a property's net annual rental.

Thus, the aesthetic values only cover property values within 1 km zone around the Yarra River for urban Melbourne and does not include units or apartments. A more appropriate hedonic study for the Yarra will need to consider actual physical conditions of the river and its riparian zone.

Only two regulating services values were quantified in this study. The carbon market calculations are based on an estimate of the volume of stored carbon in forests and wetlands, the CO_2-equivalent per tonne per year. Forested and wetland areas were analysed via GIS mapping. Avoided desalination costs are based on an estimate of water withdrawn from the Yarra.

The estimated value of diverted water is based on volumes and cost of water diverted from the Upper and Lower Yarra zones, and the water provision service fee per ML. It is important to note that additional value is added beyond the cost of the water when the diverted water is used for productive purposes such as in horticultural production. The value of the Yarra River through irrigation was based on yield gains and avoided quality losses from cherry fruits. The estimated benefit was extrapolated across the 2,515 ha of horticultural land use within 1 km of the Yarra. While irrigation water is vital for yield outcomes, extracted water is also used for spraying fruits to avoid cracking (Measham et al. 2013) and extreme heat damage management. This is a conservative estimate given the limited data on actual horticultural crops grown within 1 km of the Yarra River.

Summary

Identified critical gaps and implications

Major gaps and their implications

The Yarra Strategic Plan is not a trivial or inexpensive initiative. While the potential benefits are very significant across multiple ecosystem services, the investment does come at an opportunity cost to the community (what else could be achieved with the same levels of investment?).

There are a number of critical gaps in information that will make establishing business cases for major interventions (e.g. planning controls) and investments difficult and less convincing for policy makers and investors. Critical gaps include:

- **Quantitative metrics and cause/effect relationships.** While there are very good conceptual models of the ecosystem services delivered by waterways, robust metrics to measure the cause/effect relationship between interventions and outcomes are often not well known. This is particularly the case for green infrastructure options. The implication is that decision makers and investors will tend to favour engineering solutions as they are perceived as less risky.
- **Limitations on scope.** There are significant gaps in the scope of technical assessments available to underpin any assessment of the value of ecosystem services from the Yarra. Furthermore, the scope of economic valuations to draw upon is even more limited. The implication for the YSP is that any estimates developed will be underestimates of the value of ecosystem services and the overall value of the Yarra.
- **Lack of local studies.** Much of the studies used to develop the estimates in this report have been drawn from previous work undertaken outside the Yarra. While values in the Yarra are likely to be similar, the high reliance on 'benefit-transfer' does reduce the robustness of the estimates developed, and the ability to establish robust business cases for investors.
- **Marginal estimates needed for business cases.** Estimates presented in this report are total estimates, while the marginal estimates from this and other studies will be needed to underpin individual project business cases.
- **Social survey limitations on understanding recreational values.** While the major social surveys conducted provide excellent data and insight for managing the Yarra, the lack of detailed geographical representation of respondents' residential location and the location of principal recreational activities precludes the development of robust estimates of the value of recreation. Some relatively minor amendment to any subsequent social survey would overcome these deficiencies.
- **Static base line.** The estimates in this report are based on an assumption of a 'static baseline' – the underlying land use, water use, and recreational activities etc. wont' change. However, existing economic, social, demographic and physical (e.g. climate change) drivers will result in a changing baseline of ecosystem services attributable to the Yarra. This creates a risk that targets for any interventions and/or the scale of interventions to meet targets will likely be inaccurate.
- **Public goods and the distribution of benefits.** Many of the ecosystem services identified in this report relate to what economists call 'public goods'. Furthermore, a single class of natural capital (e.g. riparian zones) provides multiple benefits to multiple entities, reducing the likelihood that any single entity has sufficient incentive to undertake investments on their own. The implication for the YSP is that simply coordinating investments may not provide sufficient incentives to undertake some activities. The establishment of some form of 'pooled investment fund' may be required to ensure activities that deliver widely distributed benefits are actually funded.
- **Regulatory constraints on Melbourne Water's activities**. A related issue to public goods and the distribution of benefits will be the regulatory constraints on what are perceived to be 'prudent and efficient' activities for Melbourne Water and the ability to pass on costs to customers via regulated charges. This is a function of the relatively narrow scope of regulated functions.

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