The ecosystem service value of Westernport Bay

AUSTRALIAN CONSERVATION FOUNDATION

Prepared for Westernport & Peninsula Protection Council

NEW ECONOMICS ADVISORY SERVICE
AUSTRALIAN CONSERVATION FOUNDATION

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Contents

SUMMARY ____ 4
BACKGROUND ____ 7
ECOSYSTEMS OF WESTERNPORT BAY ____ 8
WHAT ARE ECOSYSTEM SERVICES? ____ 9
METHODOLOGY FOR VALUING ECOSYSTEM SERVICES ____ 12
ANNUAL VALUES OF ECOSYSTEM SERVICES ____ 13
ESTIMATES OF SITE-SPECIFIC VALUES ____ 19
CONCLUSIONS ____ 22

SUMMARY

Westernport Bay is a large tidal bay located south-east of Melbourne and contains Phillip Island, a popular holiday and tourist destination and French Island.

The Westernport and Peninsula Protection Council asked ACF's New Economics Advisory Service to estimate a value of the ecosystem services provided by Westernport Bay.

'Ecosystem services' are the tangible goods and intangible services that provide benefits to humans. These benefits provided by ecosystems are typically classified as either as provisioning, regulating, habitat or cultural & amenity services. The idea of ecosystem services acknowledges that humans can obtain both market and non-market benefits from ecological processes.

Ecosystem services are diverse and vary across different landscapes. For example, a forest provides a different range of services to a tidal bay. For this reason, it is important when discussing ecosystem services to understand the land cover, and the ecosystem services that are relevant to a particular land cover.

The table below shows the land cover types and ecosystem services that are broadly applicable to Westernport Bay.

LAND COVER	**ECOSYSTEM SERVICES APPLICABLE TO LAND COVER**							
Coastal & Marine	Disturbance regulation	Water supply	Nutrient Cycling	Waste treatment	Biological Control	Habitat / Refugia	Aesthetic & Recreation	Cultural & Spiritual
Coastal shelf		•	•		•			•
Beach	•						•	•
Estuary	•	•	•		•	•	•	•
Saltwater wetland	•			•		•	•	•

Once the ecosystem services for a particular land cover have been defined, the next step involves assigning an economic value to them.

For this report, we have chosen to transfer values from a single study, Costanza et al. (2006), because it provides data for a range of ecosystem services based on a global literature review. Costanza et al. (2006) reviewed the global body of literature on ecosystem services and calculated estimates for ecosystem service benefits using annual values per acre in 2004 USD.

To apply values to Westernport Bay, we took the annual per acre values presented by Costanza et al. for the identified ecosystem services above and applied them to known land cover applicable to the bay. The broad process for this is shown in the chart below.

Converting Costanza et al.'s estimates to Australian Dollars (AUD), we arrived at the estimates shown in the table below.

Table 1: Estimated land cover extent and total annual value (AUD) of ecosystem services in Westernport Bay

	Area in Westernport Bay	Total annual value of ecosystem services based on "A" studies *Low estimate*	Total annual value of ecosystem services based on "A-C" studies *High estimate*
	hectares	2004 AUD/yr	2004 AUD/yr
Coastal & Marine (total)	68,000	$489,190,000	$1,688,316,000
Coastal shelf	NA	NA	NA
Beach	NA	NA	NA
Estuary and Tidal Bay	65,624	$154,456,000	$2,516,134,000
Saltwater Wetland	2,376	$51,023,000	$47,926,000

Adding the values for 'Estuary and Tidal Bay' and 'Saltwater Wetland' applicable to Westernport Bay, we can estimate the annual value of ecosystem services at between $205 million and $2.6 billion expressed in 2004 AUD.

The reason for the large variance is due to the inclusion of 'nutrient cycling' services in the upper estimates for values associated with estuaries and tidal bays. Despite this, a reality

check with empirical data for fishing and tourism in the region suggests that such a range of values is reasonable.

Using the same approach to discounting as Costanza et al. (2006), the present value of ecosystems services provided by Westernport Bay is estimated at between $7 billion and $88 billion.

Some data on the ecosystems of Westernport is over three decades old and limited disaggregated economic data is available for various uses and values associated with the bay. Despite this, we hope that the analysis in this report provides a starting point for further discussion about the economic value of Westernport Bay.

BACKGROUND

Westernport Bay is a large tidal bay located south-east of Melbourne and contains Phillip Island, a popular holiday and tourist destination and French Island.

The Westernport and Peninsula Protection Council asked ACF's New Economics Advisory Service to estimate a value of the ecosystem services provided by Westernport Bay.

Westernport Bay faces a number of threats, some of which were outlined by the 2011 Melbourne Water report, 'Understanding the Westernport Environment' (p.13):

- Water and sediment quality.
- Habitat loss and fragmentation.
- Extraction and disturbance.
- Sea level rise.
- Temperature increase.
- Increased UVB rays.
- Pests.
- Cumulative impacts.

The potential impact of large-scale or cumulative impact of smaller-scale developments is also a significant threat to the bay. As the Melbourne Water report notes:

> *Saltmarshes have been progressively lost already, mostly because of development for agriculture and industry, around the western and northern shores of Western Port.*
> *(p.11)*

We hope that this work is useful to continuing discussion around development and conservation of Westernport Bay.

ECOSYSTEMS OF WESTERNPORT BAY

Westernport Bay is a tidal bay covering an area of approximately 680km2. Of this area, an estimated 130km2 is comprised of sea grasses, 24km2 are wetlands and 15km2 are mangroves. Other important habitats are the water column, mud, saltmarshes and rocky reefs.

The marine and intertidal waters of the bay support a rich marine invertebrate fauna. At least 1,350 species have been recorded in Westernport Bay, approximately three to four times greater than the number recorded in nearby Port Phillip Bay.

There are three Marine National Parks within Westernport Bay; Yaringa Marine National Park, French Island Marine National Park and Churchill Island Marine National Park.

Westernport Bay was listed as a Ramsar site of significance in 1982 and is also part of the UNESCO recognized Mornington Peninsula and Westernport Biosphere Reserve.

In addition, the bay makes a significant contribution to Australia's obligations under a suite of international conservation treaties and agreements including:

- Bonn Convention for wildlife conservation
- China-Australia Migratory Bird Agreement
- Japan-Australia Migratory Bird Agreement
- Republic of Korea-Australia Migratory Bird Agreement
- The Shorebird Reserve Network for the East Asian-Australasian flyway
- Part of a global network of Birdlife International's important bird areas.
- Most of the important roosting sites in Westernport for shorebirds are listed as Sites of National Zoological Significance.

One of the most significant environmental studies of Westernport Bay was commissioned by the Victorian Government in the 1970s. Financed partly by industry and directed by Professor Maurice Shapiro, the research was carried out beginning in 1973 and a 'Preliminary Report on the Westernport Bay Environmental Study' was published in 1975

by the Ministry for Conservation. Work on a number of Shapiro projects continued for another 10 years, finally resulting in some 200 reports and publications.

Further to the Shapiro studies, which included intensive studies of the hydrodynamics of the bay as well as its ecology, more recent information about the ecosystem and species of Westernport Bay can be found in the 2011 report by Melbourne Water titled "Understanding the Westernport Environment: A summary of current knowledge and priorities for future research". The authors of that report claim "it is remarkable what little knowledge about Westernport has been added since the 1970s…much of our knowledge of the state of the Westernport ecosystem is now more than 35 years old" (p.8). Since the 1970s, however, many non-government organisations including the Westernport and Peninsula Protection Council, the Phillip Island Conservation Society, Birdlife Australia, Victorian National Parks Association, the Australian Conservation Foundation and Environment Victoria have contributed data and analysis published principally in submissions to administrative bodies, newsletters and other 'grey' literature.

WHAT ARE ECOSYSTEM SERVICES?

The ecosystems of Westernport Bay provide both tangible goods and intangible services that are valuable to humans. Economists refer to these goods and services as 'ecosystem services'.

The Economics of Ecosystems & Biodiversity (TEEB) project classifies ecosystem services as provisioning, regulating, habitat or cultural & amenity services. The idea of ecosystem services acknowledges that humans can obtain market and non-market benefits from ecological processes. Ecosystem services are often undervalued because of a lack of institutions and incentives to preserve them and because their value is often eroded

incrementally over a long time. This reduces the severity of immediate losses, but can lead to long-term declines in ecosystem health, a 'death by a thousand cuts'.

Ecosystem services are diverse and vary across different landscapes. For example, a forest provides a different range of services to a tidal bay. For this reason, it is important when discussing ecosystem services to understand the land cover, and the ecosystem services that are relevant to a particular land cover.

For the purpose of this report, we will use the same land cover types and ecosystem services as Costanza et al. (2006)[1] (p.17). Because we are investigating Westernport Bay, we will only consider the "Coastal & Marine" category of ecosystem services. These are shown in the table below, along with the ecosystem services that were attributed to each land cover type by Costanza et al.

LAND COVER	**ECOSYSTEM SERVICES APPLICABLE TO LAND COVER**							
Coastal & Marine	Disturbance regulation	Water supply	Nutrient Cycling	Waste treatment	Biological Control	Habitat / Refugia	Aesthetic & Recreation	Cultural & Spiritual
Coastal shelf		●	●		●			●
Beach	●						●	●
Estuary	●	●	●		●	●	●	●
Saltwater wetland	●			●		●	●	●

In the table above, we have included ecosystem service values based on type A – C literature as defined by Costanza et al. (2006). Type A ecosystem service values are derived from peer reviewed or sources. Type B and C studies are from literature that may not have been peer reviewed. Readers who want further information about this classification are directed to table 2 on page 12 and table 5 on page 18 of Costanza et al. (2006).

[1] Costanza, R., Wilson, M., Troy, A., Voinov, A., Liu, S., & D'Agostino, J. (2006). The Value of New Jersey's Ecosystem Services and Natural Capital. Gund Institute for Ecological Economics, Burlington, Vermont.

Our implicit assumption is that the ecosystem services provided by Westernport Bay are broadly similar to those defined under the Coastal & Marine category of land cover marked in the table above. Costanza et al. (2006) do not provide descriptions of these land use categories, however the authors state that:

> *"A New Jersey-specific land cover typology was developed by the research team for the purposes of calculating and spatially assigning ecosystem service values. This typology is a variant of the New Jersey Department of Envrionmental Protection (NJDEP) classification for the 1995/97 Land use/Land cover (LULC) by Watershed Management Area layer."* (p.13)

Descriptions of these land use covers can be found online[2] and on pages 13-15 of Costanza et al. (2006).

Readers wanting further information about the economics of ecosystem services are directed to the following seminal papers and reports, in addition to Costanza et. al. (2006)

Costanza, R., D'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., et al. (1997). The value of the world's ecosystem services and natural capital. Nature, 387(6630), 253–260. doi:10.1038/387253a0

Costanza, R., Groot, R. De, Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., et al. (1998). The value of ecosystem services : putting the issues in perspective. Ecological Economics, 25, 67–72.

De Groot, R., Brander, L., Van der Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., et al. (2012). Global estimates of the value of ecosystems and their services in monetary units. Ecosystem Services, 1(1), 50–61. doi:10.1016/j.ecoser.2012.07.005

MA. (2003). Ecosystems and Human Well-Being: A Framework For Assessment. Millennium Ecosystem Assessment,. Retrieved from http://www.unep.org/maweb/en/Framework.aspx

TEEB. (2010). The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington.

[2] http://www.state.nj.us/dep/gis/digidownload/metadata/lulc02/anderson2002.html

METHODOLOGY FOR VALUING ECOSYSTEM SERVICES

Once the ecosystem services for a particular land cover have been defined, the next step involves assigning an economic value to them. Economists use a number of techniques in order to do this, observing 'revealed' preferences through actual behavior, as well as 'stated' preferences through surveying.

Values estimated should not be interpreted as the entire value of the ecosystem service, but rather an attempt to place an *economic* value on the service. This is an important distinction and Costanza et al. (2006) discuss the issue of value in more detail.

The methodology used in this report is known to economists as a values transfer approach. We have chosen to transfer values from a single study, Costanza et al. (2006), because it provides data for a range of ecosystem services based on a global literature review. Costanza et al. (2006) reviewed the global body of literature on ecosystem services and calculated estimates for ecosystem service benefits using annual values per acre in 2004 USD.

To apply values to Westernport Bay, we took the annual per acre values presented by Costanza et al. for Type A and Type A-C studies for the identified ecosystem services above and applied them to known land cover applicable to the bay. The broad process for this is shown in the chart below.

Although this kind of value transfer of a value transfer-based study might seem fraught with difficulties, we take the same position as Costanza et al. (2006) (pp.49-52):

> *"…the final estimates are not extremely precise. However, they are much better estimates than the alternative of assuming that ecosystem services have zero value, or, alternatively, of assuming they have infinite value. Pragmatically, in estimating the value of ecosystem services it seems better to be approximately right than precisely wrong." (p.50)*

This approach is known as a 'top-down' approach whereby known figures per unit ($/acre/yr) are applied to a known area (Westernport Bay). To give this top-down approach using global values some local context, locally relevant information is also discussed relating to tourism expenditure (recreational values) and commercial fishing (provisioning) values.

The biggest hindrance to this work is the lack of comprehensive information about the nature and scale of the ecosystem services provided by Westernport Bay.

ANNUAL VALUES OF ECOSYSTEM SERVICES

The tables below provide details on the data and calculations used in this report to estimate the annual value of ecosystem services provided by Westernport Bay.

Table 2 lists the areas of land cover type identified by Costanza et al. (2006) and the estimated average value per acre per year in 2004 USD for each.

Table 2: Average annual value of ecosystem services estimated by Costanza et al. (2006)

	Area in New Jersey	Average annual value of ecosystem services based on "A" studies	Average annual value of ecosystem services based on "A-C" studies
	acres	2004 USD/acre/yr	2004 USD/acre/yr
Coastal & Marine (total)	953,892	$2,187	$7,546
Coastal shelf	299,835	$620	$1,299
Beach	7,837	$42,149	$42,149
Estuary and Tidal Bay	455,700	$715	$11,653
Saltwater Wetland	190,520	$6,527	$6,131

Source: Derived from Table 6 on page 20 of Costanza et al. (2006). Further detail is contained in Tables 4 and 5 and Appendix C.

Table 3 provides estimates on the applicable area of land cover type attributed to Westernport Bay for the purpose of quantifying a best guess at the value of ecosystem services. To remain consistent with Constanza et al., we have used acres.

Table 3: Estimated land cover extent and total annual value (USD) of ecosystem services in Westernport Bay

	Area in Westernport Bay	Total annual value of ecosystem services based on "A" studies	Total annual value of ecosystem services based on "A-C" studies
	acres	2004 USD/yr	2004 USD/yr
Coastal & Marine (total)	168,031	$367,403,532	$1,268,000,416
Coastal shelf	NA	NA	NA
Beach	NA	NA	NA
Estuary and Tidal Bay	162,160	$116,002,987	$1,889,728,478
Saltwater Wetland	5,871	$38,320,689	$35,993,133

Source for areas of Westernport Bay: Melbourne Water (2011) Understanding the Western Port Environment: A summary of current knowledge and priorities for future research. p. 51 and p.121.

Table 3 takes the known land cover types relevant to Westernport Bay and multiplies these areas by the average annual value of ecosystem services for each land cover identified by Costanza et al. (2006).

Table 4 converts the 2004 USD figures to 2004 AUD figures.

Table 4: Estimated land cover extent (acres) and total annual value (AUD) of ecosystem services in Westernport Bay

	Area in Westernport Bay	Total annual value of ecosystem services based on "A" studies *Low estimate*	Total annual value of ecosystem services based on "A-C" studies *High estimate*
	acres	2004 AUD/yr	2004 AUD/yr
Coastal & Marine (total)	168,031	$489,190,000	$1,688,316,000
Coastal shelf	NA	NA	NA
Beach	NA	NA	NA
Estuary and Tidal Bay	162,160	$154,456,000	$2,516,134,000
Saltwater Wetland	5,871	$51,023,000	$47,926,000

Table 5 converts the acres figures to hectares.

Table 5: Estimated land cover extent (ha) and total annual value (AUD) of ecosystem services in Westernport Bay

	Area in Westernport Bay	Total annual value of ecosystem services based on "A" studies *Low estimate*	Total annual value of ecosystem services based on "A-C" studies *High estimate*
	hectares	2004 AUD/yr	2004 AUD/yr
Coastal & Marine (total)	68,000	$489,190,000	$1,688,316,000
Coastal shelf	NA	NA	NA
Beach	NA	NA	NA
Estuary and Tidal Bay	65,624	$154,456,000	$2,516,134,000
Saltwater Wetland	2,376	$51,023,000	$47,926,000

Adding the values for 'Estuary and Tidal Bay' and 'Saltwater Wetland', we can estimate the annual value of ecosystem services for Westernport Bay at between $205 million and $2.6 billion expressed in in 2004 AUD.

Using the broader 'Coastal & Marine' land cover type results in an annual value of between $489 million and $1.7 billion. The reason for the difference in figures is due to the inclusion in the Coastal & Marine category of values for 'Coastal shelf' and 'Beach' land cover types that bring down the average value per acre. The 'Estuary and Tidal Bay' category has a very high mean A-C value and so applying this value to a larger area results in the higher estimate of $2.6 billion.

These figures are intended as rough, rather than precise, estimates to indicate the potential magnitude of values provided by Westernport Bay's ecosystem services.

Low estimates include:

- Water Supply
- Habitat/Refugium function
- Aesthetic and recreational

High estimates include:

- Disturbance prevention
- Water supply

- Nutrient regulation/cycling
- Biological control
- Habitat/Refugium function
- Aesthetic & recreational
- Cultural & spiritual

For an explanation of the terms above, see Costanza et al (2006) (p.5). The biggest cause for the increase between low and high estimates is due to the inclusion of 'nutrient cycling'.

Nutrient cycling accounted for USD $10,658 out of a total of $11,653 of the value per acre associated with estuaries and tidal bays in Costanza et al (2006)'s upper estimate.

Nutrient cycling refers to the role of tidal bays and estuaries in cycling macronutrients potassium and nitrogen. The justification for this is described in the notes to Table 2 of Costanza et al. (1997)[3]:

The value of the oceans for global N and P cycling derives from their role as N and P sinks. If the oceans were not there, we would have to recreate this function by removing N and P from land runoff and recycling it back to the land.

DISCOUNTING ANNUAL VALUES

Estimates above of the value of Westernport Bay's ecosystem services are annual values. That is, they represent an ongoing 'flow' of benefits akin to a stream of income. In economics, income streams that accrue over a number of years are typically discounted to arrive at a single 'present value' figure. Present value is typically considered a better measure of asset value than taking values for any one particular year.

[3] This was provided to us by Professor Costanza via email. The document is named: Notes to Table2 Nature.doc. Costanza, R., D'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., et al. (1997). The value of the world's ecosystem services and natural capital. Nature, 387(6630), 253–260. doi:10.1038/387253a0

Costanza et al. (2006) discounted their annual estimates for New Jersey at a 3% discount rate in perpetuity. In practice, this simply means until the point at which the effects of discounting of future values has little impact on the aggregate total. At a 3% annual discount rate, 90% of the total value is realised within an 80 year time period. This is approximately equivalent to a full generation based on current life expectancy. This appears to be a reasonable approach to valuing something from a societal perspective.

Using the same approach to discounting, the present value of the future stream of benefits derived from 'Estuary and Tidal Bay' and 'Saltwater wetland' ecosystems services in Westernport Bay is anywhere from $7 billion to $88 billion.

Present value analysis would be particularly useful once the potential impacts to Westernport Bay under a range of different scenarios are better understood. Faced with such scenarios, the duration and extent of the impacts could be used to estimate the present value impact on the benefits ecosystem services.

Another possible way to look at the capital or asset value of Westernport Bay would to ask what the market would charge to provide the ecosystem services provided by the Westernport Bay. This is a kind of replacement value approach and conceivably, such large scale ecosystem engineering is possible, if not often considered. No estimates of this value exist but it is worth considering in any discussion about the value of Westernport Bay, since the market value provides perhaps the most intuitively understood method of valuation and ecosystem service valuations involve necessary uncertainty.

ESTIMATES OF SITE-SPECIFIC VALUES

To assess the validity of the 'range finder' estimates provided in the previous section, we will now investigate size of values directly attributable to habitat and recreational values of Westernport Bay.

The purpose of this is to understand if our estimates above are in the ball park and are not unreasonably high or low, given what we know about site-specific values.

Commercial fishing

Commercial fish catch values are one proxy for the value of habitat provided by Westernport Bay. Although only limited long line fishing remains in the bay following license buy backs and bans on net based fishing, historical data indicates that the annual catch value of commercial fishing reached peaks of $639,000 in the mid 1990's[4]. Following new regulations to limit commercial fishing in the bay, the catch value is now more likely to be less than $50,000. However, the peak and longer term average values provide some insight into the value of habitat as measured through market prices for fish caught. This does not however indicate that such catch levels were sustainable. Another way of considering this value is the opportunity cost of preserving habitat and viable populations, as opposed to fishing the species commercially.

[4] http://www.dpi.vic.gov.au/fisheries/commercial-fishing/commercial-fish-production-2011/western-port-value

Recreational fishing

There is no disaggregated data on the value of recreational fishing to Westernport Bay. However, a study by VRFISH (2009)[5] looked at recreational fishing in Victoria and included a Melbourne & Port Philip region which included Westernport. The study looked at the 'net benefits' including direct costs and benefits associated with recreational fishing. The study also looked at flow on impacts but for methodological reasons we will not include flow on impacts[6].

Based on surveys, VRFISH estimated that the value of recreational fishing activity in the Melbourne/Port Philip region was $229 million (28 per cent of the Victorian total). The author's survey results indicated that approximately 20 per cent of fishing in Victoria takes place in estuaries. Assuming this percentage holds for the Melbourne/Port Philip region and Westernport is the largest are that could be classified as an estuary, we can provide a rough estimate that recreational fishing in Westernport provides up to $46 million in annual gross regional product (approximately equivalent to expenditure).

Tourism

A Tourism Research Australia study[7] published in 2011 provides estimates of the value of tourism to Phillip Island. The study estimated that annual direct expenditure in Phillip Island at $391 million with associated expenditure of $1.9 billion. The smaller estimate relates only to expenditure on accommodation while the largest estimate relates to associated trip expenditure.

[5] VRFish (2009) Economic Study of Recreational Fishing in Victoria. Prepared by Ernst and Young.
[6] The use of input-output multipliers in economic impact assessment has a number of limitations discussed by the Australian Bureau of Statistics: http://bit.ly/10yfWI3
[7] Tourism Research Australia (2011) *The Economic Importance of Tourism in Australia's Regions*.

Reality Check

Combining the reported figures for commercial fishing, recreational fishing and tourism more broadly, we arrive at an annual figure of $437 million. Our lowest estimate for the annual value of ecosystem services is $205 million.

Based on this reality check, our lower and upper estimates appear to be realistic in terms of an order of magnitude test. That is, they are not conspicuously high or low by comparison to surrounding economic activity.

Combining this figure of $437 million with the wider benefits of tourism of $1.9 billion, the upper range figure of $2.6 billion also appears to be reasonable.

CONCLUSIONS

We estimate that Westernport Bay generates ecosystem services valued at between $205 million and $2.6 billion per year.

Discounting these annual values to a present value using 3% discount rate in perpetuity, we arrive at a present value of Westernport Bay of between $7 billion and $88 billion.

The reason for the large difference between the low and high estimate is due to the inclusion of 'nutrient cycling' services in the upper estimates for values associated with estuaries and tidal bays. Despite this, a reality check with empirical data for fishing and tourism in the region suggests that such a range of values is reasonable.

Some data on the ecosystems of Westernport is over three decades old and limited disaggregated economic data is available for various uses and values associated with the bay. We hope that the analysis in this report provides a starting point for further discussion about the economic value of Westernport Bay.