Data to account for environmental and socioeconomic assets: case study comparisons

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Data used within case studies reviewed in NESP2 MaC Hub Project 1.17. For further details see the full project report.

Data is organized by assets (ecosystem extent), condition, services (types and flows), and benefits. For services units of measure are provided. Where data was considered an entry of: √ indicates this type is relevant to study and data available and included; x noted in study as relevant but not included as data not available; otherwise left blank as not mentioned as relevant to study. The ( ) indicate detailed data notes and reference to note number below.

Case study location	**User/ beneficiary of service**	**Geographe Bay Marine Park (WA)**	**Port Philip Bay (Vic)**	**Great Barrier Reef (Qld)**	**Great Barrier Reef (Qld)**
Study method		SEEA EA	SEEA EA	TEV	Ecosystem Services
Valuation based upon		Exchange values	Exchange values	Welfare values	Welfare values
Year published		2020	2016	2017	2021
Ecosystem Extent					
Seagrass meadows (ha)		√ (1)	√ (18)		
Rocky reefs (ha)		√ (1)			
Sandy bottoms (ha)		√ (1)			
Kelp forests (ha)		√ (1)			
Mangroves/saltmarsh			√ (18)		
Sediments			√ (18)		
Coral habitats					√ (32)
Ecosystem Condition					
Seagrass meadows density score		√ (2)			
Fish count (count)		√ (2)			
Fish biomass (kgs)		√ (2)			
Fish species diversity (count)		√ (2)			
Abundance of specific fish species (count)		√ (2)			
Whale migration sightings (count)		√ (3)			
Condition data for specific identified ecosystems			x		
Reef condition index					√ (34)
Contextual biophysical data					
Depth		√ (4)	√ (24)		
Sea surface temperature (climate change indicator)		√ (5)			
Primary productivity hotspot		√ (6)			
Chlorophyll-a (water quality indicator)		√ (7)			
Dissolved oxygen (water quality indicator)			√ (19)		
Water quality index (water quality indictor)			√ (25)		

Case study location	User/ beneficiary of service	Geographe Bay Marine Park (WA)	Port Philip Bay (Vic)	Great Barrier Reef (Qld)	Great Barrier Reef (Qld)
Nitrogen loads (water quality indictor)			√ (26)		
Climate change scenarios and impacts on corals					√ (33)
Services & benefits					
Commercial fisheries (kgs of catch)	Industry	√ (8)	x		√ (35)
Commercial fisheries ($ sales value of catch)	Industry	√ (8)	x	x (30)	
Commercial fisheries ($ Gross operating surplus)	Industry	√ (8)			
Commercial fisheries ($ consumer + producer surplus)	Households/ Industry				√ (36)
Commercial fishing vessels (Number)	Industry	√ (8)			
Commercial aquaculture (kgs produced)	Industry		x		
Commercial aquaculture ($ value of production)	Industry		x	x (30)	
Fish nursery services (kgs)	Environment	√ (9)	√ (20)		
Fish nursery services ($ value)	Environment	X	√ (20)		
Recreational fishing (kgs of catch)	Households	√ (10)	x		
Recreational fishing (estimate $ value)	Households	x (10)	x	x (30)	
Recreational fishing (number of fishing trips)	Households	√ (11)			
Recreational fishing ($ value of fishing trips)	Households	x (11)			
Recreational vessels (number fishing visits)	Households	√ (12)			
Recreational fishing ($ consumer + producer surplus value)	Households/ Industry				√ (41)
Visitors to park for various recreation activities (number people)	Households	√ (13)	x (21)	√ (28)	
Visitors to park for various recreation activities ($ value)	Households	x (13)	x (21)	√ (28)	
Tourism (domestic visitor numbers)	Industry	√ (14)			
Tourism (domestic visitor $ value)	Industry	x (14)			
Tourism (domestic visitor numbers)	Households			√ (29)	
Tourism (domestic visitor $ value)	Households			√ (29)	
Tourism ($ consumer + producer surplus value)	Households/ Industry				√ (40)

Case study location	**User/ beneficiary of service**	**Geographe Bay Marine Park (WA)**	**Port Philip Bay (Vic)**	**Great Barrier Reef (Qld)**	**Great Barrier Reef (Qld)**
Vessel stops/parking (numbers of vessels parking for specified lengths of time)	Industry/ Households	√ (15)			
Vessel stops/parking ($ value)	Industry/ Households	x (15)			
Coral harvesting (tonnes)	Households/ Industry				√ (37)
Coral harvesting ($ consumer + producer surplus)	Households/ Industry				√ (37)
Carbon sequestration (tonnes carbon sequestered)	Government	√ (16)	√ (22)		
Carbon sequestration ($ value)	Government	√ (16)	√ (22)		
Denitrification/water filtration services (tonnes of nitrogen processed)	Government		√ (23)		
Denitrification/water filtration services ($ value)	Government		√ (23)		
Other ecosystem services beyond tourism & recreation incl regulating and supporting services				x	
Traditional Owner values ($ estimate)				x (31)	√ (43)
Medicinal option values ($ value estimate)					√ (38)
Storm surge protection values ($ value estimate)					√ (39)
Non-use value to Australians ($ annual value estimated using contingent valuation method from survey data)				√ (27)	√ (42)
Non-use value to international residents ($ annual value estimated using contingent valuation method from survey data)				x (27)	
Scientific research values				x (30)	
Contextual data for services/beneficiaries					
Population within coastal LGAs		√ (17)			
Monetary value of asset					
Non-use value to Australians ($ net present value estimated using contingent valuation method from survey data)				√ (27)	
Non-use value to international residents ($ net present value estimated using contingent valuation method from survey data)				x (27)	
Direct use value to Australian tourists ($ net present value				√ (29)	

Case study location	User/ beneficiary of service	Geographe Bay Marine Park (WA)	Port Philip Bay (Vic)	Great Barrier Reef (Qld)	Great Barrier Reef (Qld)
estimated using travel cost method from survey data)					
Direct use value to international tourists ($ net present value estimated using travel cost method from survey data)				x (29)	
Direct use visitors to park for various recreation activities ($ net present value)				√ (28)	

Detailed data notes:

(1) Spatial data for 2014 (estimated based on historic data), with modelling used to interpolate data to estimate missing values. Data from CSIRO, 2015; Department of Parks and Wildlife, 2006; Lawrence et al., 2016; Lucieer et al., 2017.
(2) Spatial files interpolated from point data from Lawrence et al., 2016
(3) Number of sightings of Blue whale, Humpback whale and Southern right whale in park per daylight hours in migration months, Burton et al, unpublished
(4) Spatially based data on water depth from bathymetry data, Geoscience Australia, 2017
(5) Spatial based on satellite data AODN, 2014
(6) Spatial modelled from satellite data Geoscience Australia, 2014
(7) Spatial based on satellite data, NASA, 2020
(8) Data apportioned to estimate value within park, based on data from Department of Primary Industries and Regional Development, 2020
(9) Values transferred from studies in New South Wales from Jänes et al., 2020
(10) Data apportioned based on population in coastal area, data for catch of western rock lobster, blue swimmer crab and King George whiting from Ryan et al., 2019. Monetary value supply and use table not produced as the exchange price was unknown – whilst market value of catch could be estimated the value to the fisher of the fishing experience was unknown.
(11) Number of trips from boat ramp survey data, Navarro, 2020. Values were transferred based on McLeod & Lindner, 2018, but monetary supply and use table not produced as the estimates were of gross willingness to pay and consumer surplus, rather than exchange values.
(12) Number and destination within park of trips from boat ramp survey data, Navarro, 2020
(13) Survey data on domestic visitor activity numbers, which includes whale watching, surfing, water activities/sports, fishing, and going to the beach, from Tourism Research Australia, 2019. Exchange values for the benefits from these activities are not known, and the proportion of the value that relates to the marine park (and the specific ecosystems of interest) is also unknown
(14) Visitors to the region who participated in marine activities during their stay based on visitor survey data, Tourism Research Australia, 2019. Whilst information also available on the total expenditure, tourism value added, wages and salaries within the tourism sector and employment numbers, for the wider region including the park, from REMPLAN, 2020, and Tourism Research Australia, 2019, these data could not be appropriately attributed to the

park itself (or specific ecosystems) and exchange values were not available, and thus monetary supply and use tables could not be presented.

(15) Data was restricted to boats that have their Automatic Identification System (AIS) on, and vessels may turn this off. AIS data from Australian Maritime Safety Authority, 2020. No attempt to estimate value for the service

(16) Carbon sequestered by the seagrass meadows estimated from Serrano et al., 2019. The exchange value of sequestered carbon then estimated using the market price based upon ACCU spot prices.

(17) Source of population data within coastal LGAs not specified

(18) Spatial data sourced from DELWP EnSym, including data from Warry & Hindell (2009)

(19) Data for dissolved oxygen MG/L and percent saturated dissolved oxygen estimated by DELWP sourced from Environment Protection Authority and HydroNumerics for use as condition indicator

(20) Fish enhancement from seagrass habitat data, focusing on three species (Australian anchovy, southern sea garfish and King George whiting) using data from Blandon & zu Emgassen (2014). This was monetised by applying market prices for seafood to the volume and the hectares of seagrass to estimate $ value per hectare of seagrass.

(21) Limited visitor data was available, including number of visitors and estimated willingness to pay per visit, to some parts of the park, and number of visitors to Victorian parks. However data is not available specifically for the Port Philip Bay region, and the proportion of visitors for which the seagrass (or other ecosystems) provide the key motivation for visiting is also unknown. The limited data available was sourced from Newspoll, 2013, DELWP & Parks Victoria, 2015, and from Read Sturgess ,1999.

(22) Volume of carbon sequestered by the seagrass meadows was estimated based on transferred data from other studies, see Blue Carbon initiative, Fourqurean et al., 2012, Dept of Sustainability & environment 2009, and Port Phillip and Westernport Catchment Management Authority (2015). The value for the carbon sequestered was estimated based on the prices paid in auctions for carbon units under the Australian Emissions Reduction Fund.

(23) Denitrification is a service provided by the soft muddy sediments, where nitrate is converted to nitrogen gas and released to the atmosphere thus improving water quality and reducing risk of algal blooms. Tonnes of nitrogen processed was estimated by DELWP, 2015, and value estimated based upon the cost of achieving equivalent levels of denitrification by alternate means such as wetlands enhancement.

(24) Depth across the bay from CSIRO 1996

(25) Water quality index at certain locations within the bay derived from Yarra and Bay, 2016

(26) Data on nitrogen loads entering the bay from sources including the Yarra, Werribee, Dandenong and Maribyrnong catchments, the Western Treatment Plant, and other sources. Data sourced from DELWP, 2016 Draft Port Phillip Bay Environmental Management Plan 2017-2027: Supporting Document

(27) Data obtained from a survey of individuals residing in Australia and overseas for the purpose of this study. The survey was conducted by Ipsos Public Affairs Australia on behalf of Deloitte Access Economics; survey instrument can be found in Deloitte 2017. From the data on Australians only, Deloitte used the contingent valuation method to estimate an annual willingness to pay, and the net present value. Value for international residents not estimated due to insufficient reliable data.

(28) Data reported included number of visitors to the park, by visitor type (domestic day, domestic overnight and international) and by geographic region of the park, and by purpose

(holiday, visiting family and friends, business and other), and average expenditure per visitor day or night. Data sourced from the National Visitor Survey and International Visitor Survey, Tourism Research Australia. The estimated value was calculated using benefit transfer approach, combining data on number of domestic recreation visitors from Tourism Research Australia with values from Rolfe & Gregg, 2012.

(29) Data relating to the direct use value of tourism in the GBR region was compiled using two data sources. Firstly, the survey data gathered as part of (27) above included questions relating to tourist visits to the GBR, enabling a zonal travel cost model to be developed. Secondly, this was combined with data on intrastate and interstate visitors to the GBR sourced from Tourism Research Australia, as for (28) above, to estimate annual value and net present value. Again the data used only related to domestic, not international, tourists.

(30) Each of these services were noted as contributing to employment and economic activity within the region as part of the input-output modelling exercise, but no data/values were incorporated within the TEV value estimate for the GBR.

(31) A range of Traditional Owner values were discussed qualitatively within the report, but no attempt was made to monetise the benefits or the asset values.

(32) CoCoNet model developed of the ecological extent of coral habitats, including details on different types of corals, and was calibrated against coral cover and CoTS abundance data from the Australian Institute of Marine Sciences (AIMS) long-term monitoring program (Condie et al. 2018, Condie et al. 2021).

(33) Climate change scenarios based upon the IPCC 2014 pathways, with impact on corals from tropical cyclones and associated flooding, and coral bleaching events taken from Condie et al., 2018; Anthony et al., 2019; Condie et al., 2021. This work was supported by data from other studies (Hughes et al., 2018; Lough, Anderson, & Hughes, 2018; Mellin et al., 2019; Wolff et al. 2018; Wolff et al. 2016).

(34) Reef condition index was calculated for the reefs within the CoCoNet model (see 32 above) based upon two sub-indices, for coral cover and for composition (fast-growing, branching corals compared to slow-growth corals).

(35) Data on volume of fish harvested by commercial fishing from http://qfish.fisheries.qld.gov.au/

(36) Consumer and producer surplus values estimated from volumes of fish (35) and data on value of commercial fishing derived from http://www.agriculture.gov.au/abares/research-topics/fisheries/fisheries-data#australian-fisheries-and-aquaculture-statistics-2016, with proportions of total value relating to consumer and producer surplus based upon data from De Valck & Rolfe 2018.

(37) Data on tonnes of coral harvested from areas within the marine park were obtained from http://qfish.fisheries.qld.gov.au/ Estimates of value were based upon low values for rubble, and higher prices for ornamental corals, from http://marinefishdirect.com.au/product/category?path=75, noting that higher prices for ornamental live corals partially reflect transport costs – Harriott (2001)

(38) Option value of future medicinal uses of corals were estimated based upon estimates of medicinal option values elsewhere transferred to the Reef using benefit transfer approach. Data on original study from Jobstvogt et al. 2014.

(39) Estimated based upon context of number of people living within the Reef catchment (from ABS data for Statistical Local Area (SLA) 2, with major regional centres. from ABS 2016 table builder) and value of property within the region (from https://www.yourinvestmentpropertymag.com.au/top-suburbs/qld-4870-cairns-north.aspx, accessed 19 May 2018) and estimated regularity of severe tropical cyclones

(40) Value of tourism calculated based upon number of visitors derived from GBRMPA's Environmental Management Charge (EMC) data, available at https://www.gbrmpa.gov.au/our-work/Managing-multiple-uses/tourism-on-the-great-barrier-reef/visitor-contributions2/numbers and the estimated consumer surplus based upon a number of studies (Hundloe (1989) cited in Hoagland, Kaoru, and Broadus (1995); Carr and Mendelsohn (2003); Kragt et al. (2009); Buchler (2014); Deloitte Access Economics, 2017) and the estimated producer surplus based upon de Valck & Rolfe, 2018.

(41) Value of recreational fishing consumer surplus estimated based upon values from Prayaga, Rolfe, and Stoeckl (2010). Producer surplus estimated from Delotte Access Economics, 2017, Driml, 1987; Murphy, 2002a,b., de Valck & Rolfe 2018. Estimating of the proportion of fish that are reef dependent from Webley et al., 2015.

(42) Non-use values based upon Deloitte Access Economics, 2017 and Rolfe & Windle 2012.

(43) Indigenous cultural values that are either directly or indirectly associated with the Reef (e.g. with species, related cultural values, or adjacent ecosystems) were estimated based upon Delisle et al. 2017; Social Ventures Australia Consulting 2016; Sangha et al., 2017. The study emphasises that this estimate is only a placeholder, representing a rough estimate, and that more detailed work needs to be undertaken to properly assess these values, and such work should be led by Indigenous scholars.

DATA REFERENCES

Anthony, Kenneth, R.N., Scott, A. Condie, Bozec, Y.M., Harrison, D., Gibbs, M., Baird, M., Mumby, Peter J., Mead, D., 2019. Ecological modelling methods and findings – Reef Restoration and Adaptation Program. A report provided to the Australian Government by the Reef Restoration and Adaptation Program.

AODN. (2014). MARVL3 – Australian shelf temperature data atlas [Data set]. https://researchdata.edu.au/marvl3–australian–shelf–temperature–atlas/954508

Australian Maritime Safety Authority (2020). Vessel tracking data. https://www.operations.amsa.gov.au/Spatial/DataServices/DigitalData

Blandon, A. and zu Ermgassen, P.S.E. (2014) 'Quantitative estimate of commercial fish enhancement by seagrass habitat in southern Australia', Estuarine, coastal and shelf science, Volume 141, p. 108.

Blue carbon initiative See http://www.thebluecarboninitiative.org

Buchler, David, 2014. A pragmatic solution to the problem of international visitors in the travel cost method: a case study from the Great Barrier Reef. James Cook University

Carr, Liam, Mendelsohn, Robert, 2003. Valuing coral reefs: a travel cost analysis of the Great Barrier Reef. AMBIO: J. Human Environ. 32, 353–357.

Condie, Scott A, Anthony, Kenneth RN, Babcock, Russ C, Baird, Mark E, Beeden, Roger, Fletcher, Cameron S, Gorton, Rebecca, Harrison, Daniel, Hobday, Alistair J, Plag´anyi, ´Eva E, 2021. Large-scale interventions may delay decline of the Great Barrier Reef. R. Soc. Open Sci. 8, 201296.

Condie, Scott A, Plag´anyi, ´Eva E, Morello, Elisabetta B, Hock, Karlo, Beeden, Roger, 2018. Great Barrier Reef recovery through multiple interventions. Conserv. Biol. 32, 1356–1367.

CSIRO (1996) Port Phillip Bay Environmental Study: The Findings 1992-1996, report for Melbourne Water

CSIRO. (2015). Seagrass Dataset – CAMRIS [Data set]. https://doi.org/https://doi.org/10.4225/08/5514852027A1E

De Valck, J. and Rolfe, J. 2018. Linking water quality impacts and benefits of ecosystem services in the Great Barrier Reef. Mar. Pollut. Bull. 130, 55–66.

Delisle, Aur´elie, Kim, Milena Kiatkoski, Stoeckl, Natalie, Lui, Felecia Watkin, Marsh, Helene, 2017. The socio-cultural benefits and costs of the traditional hunting of dugongs and green turtles in Torres Strait, Australia. Oryx – Int. J. Conserv. 1–12.

Deloitte Access Economics. (2017). At what price? The economic, social and icon value of the Great Barrier Reef. Deloitte Access Economics Pty Limited, Canberra, ACT, Australia https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-great-barrier-reef-230617.pdf

Department of Environment, Land, Water and Planning (2015) Protecting Victoria's Environment – Biodiversity 2036 – Consultation Draft https://issuu.com/delwpbiodiversity/docs/protecting-victorias-environment-bi

Department of Environment, Land, Water and Planning and Parks Victoria (2015) Valuing Victoria's Parks

Department of Environment, Land, Water and Planning and Parks Victoria (2016) Draft Port Phillip Bay Environmental Management Plan 2017–2027 https://www.vgls.vic.gov.au/client/en_AU/search/asset/1297519/0

Department of Parks and Wildlife (2006). Marine Habitats of Western Australia [Data set]. https://researchdata.edu.au/marine–habitats–western–australia/967321

Department of Primary Industries and Regional Development (2019). Ngari Capes Marine Park [Dataset]. https://www.arcgis.com/home/item.html?id=60dbac0439e6439abf887d583c498bf6

Department of Sustainability and Environment (2009) Review of Victorian seagrass research, with emphasis on Port Phillip Bay, p. 18

Driml, S.M., 1987. 'Economic impacts of activities on the Great Barrier Reef'.

Fourqurean, J.W. et al (2012) 'Seagrass ecosystems as a globally significant carbon stock', Nature Geoscience, Volume 5, pp 505-509.

Geoscience Australia. (2014). MODIS Derived Primary Productivity: Overall Hotspots. https://data.gov.au/dataset/ds–aodn–978bd264–a795–4959–afc5–07021e238017/details?q=

Geoscience Australia. (2017). Australian Bathymetry and Topography Grid [Data set]. https://data.gov.au/data/dataset/australian–bathymetry–and–topography–grid–june–2009

Harriott, Vicki, J., 2001. The sustainability of Queensland's coral harvest fishery (Citeseer).

Hoagland, Porter, Yoshiaki Kaoru, Broadus, James M., 1995. A methodological review of net benefit evaluation for marine reserves. Environ. Dep. Pap. Environ. Econ. Series., Paper No 027.

Hughes et al., 2018. Global warming transforms coral reef assemblages. Nature, 556: 492.

IPCC, 2014. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC. In. Geneva, Switzerland.

Jänes, H., Macreadie, P. I., Zu Ermgassen, P. S. E., Gair, J. R., Treby, S., Reeves, S., Nicholson, E., Ierodiaconou, D., & Carnell, P. (2020). Quantifying fisheries enhancement from coastal vegetated ecosystems. Ecosystem Services, 43(March). https://doi.org/10.1016/j.ecoser.2020.101105

Jobstvogt, Niels, Hanley, Nick, Hynes, Stephen, Kenter, Jasper, Witte, Ursula, 2014. Twenty thousand sterling under the sea: estimating the value of protecting deep-sea biodiversity. Ecol. Econ. 97, 10–19.

Kragt, Marit E, Roebeling, Peter C, Ruijs, Arjan, 2009. Effects of Great Barrier Reef degradation on recreational reef-trip demand: a contingent behaviour approach. Aust. J. Agric. Resour. Econ. 53, 213–229.

Lawrence, E., Hovey, R., Harvey, E., Kendrick, G., Hayes, K.R., and, & Williams, S. (2016). Application of NERP Biodiversity Hub survey methodology to Geographe Commonwealth Marine Reserve – final report. https://www.nespmarine.edu.au/system/files/Lawrence et al Application of NERP Marine Hub survey methodology to Geographe Bay CMR_Final report v11_Dec2016.pdf

Lough, J.M., Anderson, K.D., Hughes, T.P., 2018. Increasing thermal stress for tropical coral reefs: 1871–2017. Sci. Rep. 8, 6079.

Lucieer, V. et al. (2017) Seamap Australia - a national seafloor habitat classification scheme. Institute for Marine and Antarctic Studies (IMAS), University of Tasmania (UTAS).

McLeod, P., & Lindner, R. (2018). Economic dimension of recreational fishing in Western Australia. October, 83. https://recfishwest.org.au/wp–content/uploads/2019/03/Economic–Dimensions–of–Recreational–Fishing–in–Western–Australia–Report–2.pdf

Mellin, C., Matthews, S., Anthony, K. R., Brown, S. C., Caley, M. J., Johns, K. A., ... & MacNeil, M. A. (2019). Spatial resilience of the Great Barrier Reef under cumulative disturbance impacts. Global change biology, 25(7), 2431-2445.

Murphy, I. 2002a. Mackay and Whitsunday Region: Spending Habits of Recreational Fishermen and Their Contribution to the Economy. In. Margate, QLD: Sunfish and Queensland Industry of Recreational Fishing.

Murphy, I., 2002b. Townsville and Thuringowa: Spending Habits of Recreational Fishermen and Their Contribution to the Economy. In. Margate, QLD: Sunfish and Queensland Industry of Recreational Fishing.

NASA. (2020). OceanColor Web [Data set]. Earth Data. https://oceancolor.gsfc.nasa.gov/

Navarro, M. (2020). Ramp Survey Ngari Capes (unpublished).

Newspoll (2013) Parks Visitation Monitor Quarter 1-4 – 2012/2013, report prepared for Parks Victoria

Prayaga, Prabha, Rolfe, John, Stoeckl, Natalie, 2010. The value of recreational fishing in the Great Barrier Reef, Australia: a pooled revealed preference and contingent behaviour model. Marine Pol. 34 (2), 244–251.

Port Phillip and Westernport Catchment Management Authority (2015) The distribution and abundance of 'blue carbon' within Port Phillip and Westernport, p. 4

Read Sturgess (1999) Economic assessment of the recreational values of Victorian parks

REMPLAN. (2020). South West Economy Profile. https://app.remplan.com.au/rdasouthwest/economy/tourism/value–added?lang=en–US&state=0Mw9c4!8Zx5F3JBvHDNqgYu2l2r9tbikhp2KHZbgbEHkhW4hySgf9Sa5vDSEY4

Rolfe, J., & Gregg, D. (2012). Valuing beach recreation across a regional area: The GBR in Australia. Ocean & Coastal Management, 69, 282-290.

Rolfe, John, Windle, Jill, 2012. Distance decay functions for iconic assets: assessing national values to protect the health of the Great Barrier Reef in Australia. Environ. Resour. Econ. 53, 347–365.

Ryan, K. L., Hall, N. G., Lai, E. K., Smallwood, C. B., Tate, A., Taylor, S. M., & Wise, B. S. (2019). Statewide survey of boat–based recreational fishing in Western Australia 2017/18. Fisheries Research Report No. 297 (Issue 297).

Sangha, Kamaljit K, Russell-Smith, Jeremy, Morrison, Scott C, Costanza, Robert, Edwards, Andrew, 2017. Challenges for valuing ecosystem services from an Indigenous estate in northern Australia. Ecosyst. Serv. 25, 167–178.

Serrano, O., Lovelock, C. E., B. Atwood, T., Macreadie, P. I., Canto, R., Phinn, S., Arias–Ortiz, A., Bai, L., Baldock, J., Bedulli, C., Carnell, P., Connolly, R. M., Donaldson, P., Esteban, A., Ewers Lewis, C. J., Eyre, B. D., Hayes, M. A., Horwitz, P., Hutley, L. B., … Duarte, C. M. (2019). Australian vegetated coastal ecosystems as global hotspots for climate change mitigation. Nature Communications, 10(1), 1–10. https://doi.org/10.1038/s41467–019–12176–8

Social Ventures Australia Consulting Social Return on Investment analysis of the Girringun: Indigenous Protected Area and associated Indigenous ranger programme. Available at: https://www.pmc.gov.au/sites/default/files/publications/Girringun-SROI.pdf 2016.

Stoeckl, N., Condie, S., & Anthony, K. (2021). Assessing changes to ecosystem service values at large geographic scale: A case study for Australia's Great Barrier Reef. Ecosystem Services, 51, 101352. doi:10.1016/j.ecoser.2021.101352

Tourism Research Australia. (2019). National visitor survey methodology. https://www.tra.gov.au/Domestic/national–visitor–survey–methodology

Warry, F.Y., Hindell, J. S. (2009) Review of Victorian seagrass research, with emphasis on Port Phillip Bay, Department of Sustainability and Environment, Victoria

Webley, James, Kirrily McInnes, Daniella Teixeira, Ashley Lawson, and Ross Quinn. 2015. Statewide Recreational Fishing Survey 2013-14. In. Brisbane, Queensland.: Queensland Department of Agriculture and Fisheries.

Wolff, Nicholas H, Mumby, Peter J, Devlin, Michelle, Anthony, Kenneth RN, 2018. Vulnerability of the great barrier reef to climate change and local pressures. Glob. Change Biol. 24, 1978–1991.

Wolff, Nicholas H, Wong, Aaron, Vitolo, Renato, Stolberg, Kristin, Anthony, Kenneth RN, Mumby, Peter J, 2016. Temporal clustering of tropical cyclones on the Great Barrier Reef and its ecological importance. Coral Reefs 35, 613–623.

Yarra and Bay, 2016 http://yarraandbay.vic.gov.au/assets/water-quality