Article title: The cost of a promise – the species conservation expenditure needed to meet Australia's zero extinction target in the marine environment

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ABSTRACT

The Global Biodiversity Framework has the goal of halting the human-induced extinction of species. An immense number of species are threatened with extinction, the task confronting nations is great, and the cost highly uncertain. We collated cost data for marine species recovery programs in the United States where there have been some successful threatened species recoveries. Based on the average expenditure on marine species conservation for four taxonomic groups (mammals, birds, fish, reptiles), we modelled the expected expenditure required to prevent extinction of 95 threatened Australian marine species. We discovered that Australia would need to spend approximately A$280.6m/yr (2023) (U$204.8m/yr (2023)) to avert the loss of 95 listed threatened Australian marine species, indicating the need for a significant increase in public expenditure on marine species conservation over current levels. The analysis assumes that costs and marine species conservation needs in Australia are, on average, equivalent to those in the USA, and that the ratio of public to private expenditure on marine conservation in Australia is similar to that in the USA. Agencies responsible for threatened species recovery should provide realistic, species-specific estimates of conservation expenditure needs to better understand the national threatened species expenditure gap.

INTRODUCTION

Marine environments are critical to Australia's identity and economy. They are also of critical importance to many Aboriginal and Torres Strait Islander Peoples, with at least 70 Traditional Owner groups having cultural authority over the Great Barrier Reef, and 46 over the Great Southern Reef alone. It has been estimated that the marine environment contributes more than A$25 billion to the Australian Economy every year (Department of Climate Change, Energy, the Environment and Water, 2024; Pelle 2022). Australian marine ecosystems are experiencing degradation, including coral bleaching, declining mangrove ecosystems, and collapsing kelp forests (Intergovernmental Panel On Climate Change (IPCC) et al., 2022; Treloar et al. 2016), which is placing unprecedented pressures on marine species (Bergstrom et al., 2021; Dielenberg et al., 2024). Up to 99% of some Australian shellfish reefs have been destroyed since 1700 (Gillies et al., 2018); seagrass species continue to decline faster than the average global rate, despite some formal protection (Evans et al., 2018). The 2021 Australia State of the Environment report indicates seamounts, shallow rocky reefs, algal beds, and coral reefs are either in poor or declining condition nationally (Trebilco et al., 2021).

The Australian Government has made a bold commitment to "no more human-induced extinctions by 2030" (Department of Climate Change, Energy, the Environment and Water, Canberra, 2022) and is a signatory to the Global Biodiversity Framework (GBF) that commits nations to halting extinctions by 2050 (Convention on Biological Diversity, 2023). The GBF identifies that a global financial mobilisation of approximately U$800 billion in conservation funding annually is needed to achieve GBF targets and sets the specific target of increasing funding by U$200b/yr by 2030. These estimates are not broken down by action or by country. There exist very few published estimates of what preventing extinction will cost individual countries, though this would seem to be essential information to obtain if governments intend to act and deliver on their GBF promises.

The challenge of estimating the expenditure needed to conserve species has been tackled in a few different ways. McCarthy et al. (2012) estimated the expenditure needed to reduce the extinction risk of all globally threatened bird species by at least one extinction risk category (e.g., from endangered to vulnerable, or vulnerable to near threatened) using the International Union for Conservation of Nature (IUCN) Red List criteria. This was done through expert elicitation for a sample (211 species – 19% at the time) of IUCN-listed globally threatened bird species, leading to a model of cost based on several factors, including species range size, that could be applied to the full set of IUCN Red List birds.

Wintle et al. (2019) estimated the Australian terrestrial threatened species expenditure shortfall by comparing Australian expenditure to that of the US, where recovery and delisting of threatened species has been relatively successful (Greenwald et al. 2019). Unlike the US Endangered Species Act (1974), the equivalent Australian legislation for listing threatened species, the Environment Protection and Biodiversity Conservation Act (EPBC Act 1999), does not mandate the allocation of funding for species recovery once listed. The study by Wintle and colleagues assumes that US endangered species spending is approximately

sufficient, based on the delisting of 54 species following recovery, downlisting (from endangered to threatened) of 56 species, and evidence of prevented extinction for approximately 227 species (Greenwald et al. 2019). That 85% of Endangered Species Act (ESA) listed birds achieve a documented stabilisation or recovery following listing, indicates protection and recovery actions mandated by the ESA are working, at least to some extent. The same cannot be said of threatened species recovery in Australia, where delisting remains rare (only 6.5% of listed species per Woinarski et al. 2023).

A number of other studies have estimated the expenditure necessary to restore ecosystems and threatened ecological communities (e.g., Mappin et al. 2021). This is related to, and a part of, species recovery but is seldom the full story, given the number of species-specific actions required for the latter such as captive breeding, translocation and reintroduction, predator and herbivore control, and genetic rescue. Here we build on the approach used by Wintle et al. (2019) to provide an estimate of the funding needed for Australia to prevent the near-term (<10 year) extinction of the 95 EPBC Act-listed threatened marine species.

METHODS

The US Fish and Wildlife Service (USFWS) publishes annual "Federal and State Endangered and Threatened Species Expenditures" reports (USFWS 2020). These detail the financial expenditure on endangered and threatened species conservation actions, providing a level of fiscal and policy transparency not available in Australia. We draw on this report to document and analyse 2020 fiscal-year expenditure on marine species conservation in the US (the most recently available year) and apply its learnings to Australia. This practice, called benefit- or environmental benefit-transfer, uses existing data from one setting (e.g., US marine species spending) to predict estimates in a new setting where data is limited or unavailable (e.g., Australian marine species spending). As noted by Rolfe and colleagues (2015a): "The goal is to provide empirical estimates for the particular issue of interest when time, funding or other constraints prevent the use of primary research to generate these estimates." Here, we determined the per-unit average expenditure of US ESA marine species by species group and multiplied it by the number of EPBC species of that same group.

Despite the COVID-19 pandemic, threatened species spending in the US 2020 fiscal year was comparable to that of the previous five years, and as such was deemed appropriate to use, as the most recent data available (Supplementary Material, Table SM7). The expenditure report includes categories such as fisheries management, refuges, land acquisition, law enforcement, research, contributions to international conservation efforts, and regional and field office operations for listing, recovery, and consultation. It includes state-level government expenditures but does not include the expenditures of private or non-government organisations. Aggregating species-level expenditure data, we calculated average and median expenditures for marine reptiles, birds, fish, and mammals. Due to the disproportionate US investment in salmonid conservation (Salmonids had 50 times the average expenditure of other fish species – Table SM2), and the lack of equivalent commercially and culturally

important endangered species that require wide-spread catchment management in Australia, these species were excluded from our analysis. Calculations for birds include both shorebirds and seabirds.

A list of marine and marine-migratory species listed under Australia's EPBC Act was extracted from Australian government databases. Species can be protected under the EPBC Act as "marine listed species", without necessarily being deemed threatened – rather, this status is a separate form of listing that confers a level of protection via a permit system (EPBC Act 1999 (Cth) s. 248–266). There are over 475 species with this listing; however, we refined this to only those species that are also listed as threatened, since this was the focus of our analysis. We found 9 EPBC Act-listed threatened marine reptiles, 9 mammals, 23 fish, and 54 bird species (including seabirds and shorebirds), giving 95 species in total (Supplementary Material, Table SM5). US taxonomic group expenditure averages were multiplied by the number of Australian species in each taxonomic group to give taxonomic group total expenditure estimates. These were then summed to estimate the total annual marine animal conservation expenditure requirement for Australia in 2020 USD. All figures were then adjusted for inflation to USD 2023 constant dollars (i.e. multiplied by 1.177) and converted to the equivalent AUD 2023 figure. This latter conversion used the official purchasing power parity (PPP) conversion factor for the most recent year available, 2023 (1 USD = 1.370 AUD; World Bank International Comparison Program (ICP) 2026). As such, all figures are expressed in 2023 constant dollars to ensure methodological consistency between the inflation adjustment base year and the PPP benchmark year. All spreadsheet calculations are provided in Supplementary Material Table SM1–6.

RESULTS

With the removal of salmonid species from the analysis, USFWS expenditure data revealed that the taxonomic group receiving the largest per-species funding allocation in the United States was the marine reptiles (Fig. 1). This was driven by the relatively well-funded sea turtle group, including loggerhead, hawksbill, leatherback and green sea turtles (*Caretta caretta*, *Eretmochelys imbricata*, *Dermochelys coriacea*, and C*helonia mydas,* respectively). The other taxonomic groups received an average per-species funding of between A$1–4m/yr (2023), with lower median spends (Fig. 1). For comparison, the average annual salmonid per-species funding reported by USFWS was around A$160m/yr (2023).

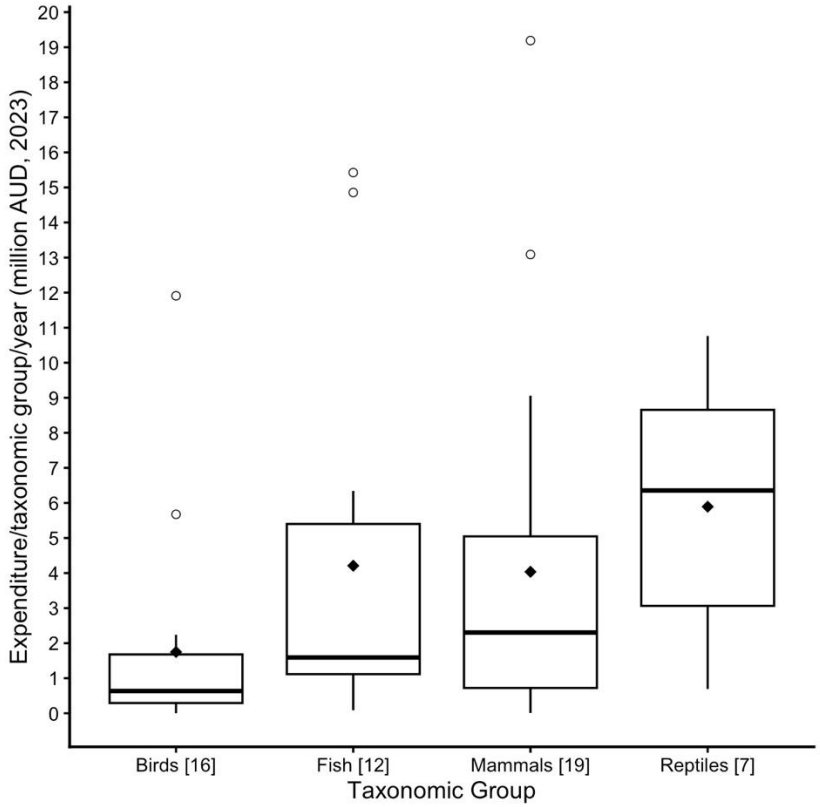


Figure 1. US expenditure (AUD, 2023) on ESA-listed species in 2020 by taxonomic group. The total number of species in each taxonomic group is shown in square brackets. Mean is shown as a diamond; median a solid black line within the box; outliers as open circles. Solid plot whiskers represent 95% confidence intervals on the mean.

When considering the number of Australian EPBC-listed threatened species in each taxonomic group and the average cost of protection for each taxonomic group derived from US expenditure data, fish and birds each require A$94–97m of conservation expenditure, while marine mammals and marine reptiles each require between A$36–53m (Fig. 2).

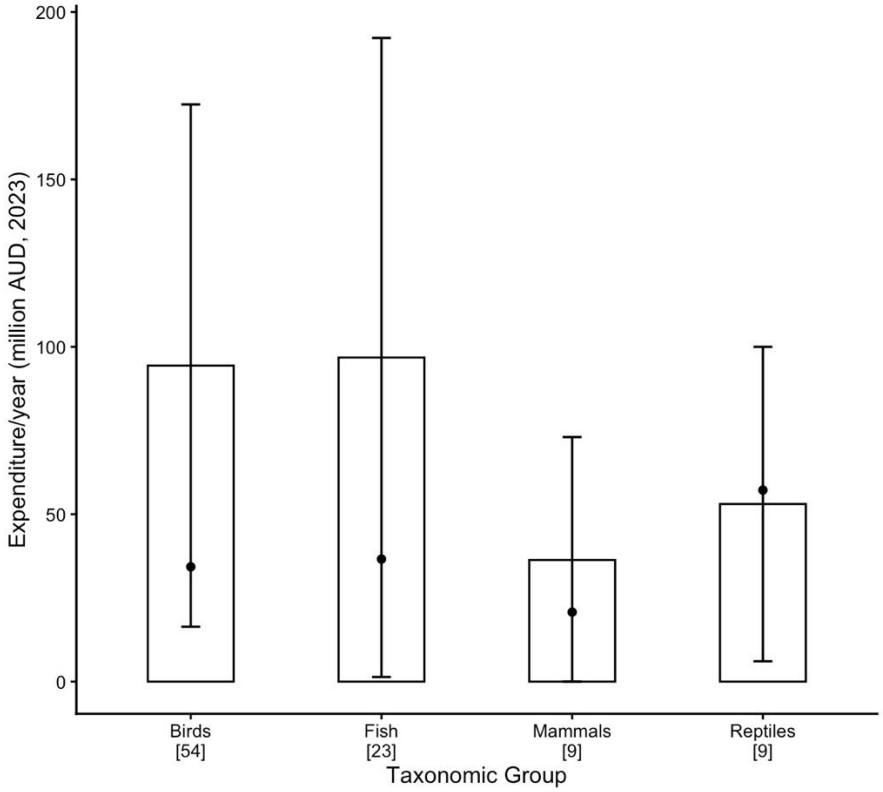


Figure 2. Estimated total annual expenditure to adequately protect and stabilize Australian EPBC-listed species by taxonomic group (AUD, 2023). Bars show mean-based totals, black circles show median-based totals, and whiskers show 95% confidence intervals propagated from the US mean estimates.

Summing across all taxonomic groups, the total estimate of funding required to prevent extinction and stabilize populations of Australia's marine species was A$280.6m based on average US expenditures (Table 1) and A$148.8m based on median US expenditures. The mean expenditure for most groups (except reptiles) is 2−3 times higher than the median in the USA because a small number of species receive relatively large funding allocations. The relatively large number of EPBC Act-listed shorebirds, seabirds, and marine fishes, and the skew toward higher mean expenditures for those species result in them making up more than 50% of the total estimated conservation expenditure required to stabilize Australia's marine EPBC Act-listed species.

Table 1. The number of ESA-listed species (column 2), mean (column 3) and median (column 4) allocated funding for taxonomic groups in the US, the number of EPBC Act-listed species under each taxonomic group (column 5), and estimated funding needs for Australian species computed for broad taxon groups based on US expenditure medians (column 6) and means (column 7).

Taxonomic Group	No. (US) ESA-Listed Species	Average ESA expenditure per US taxonomic group (AUD, 2023)	Median ESA expenditure per US taxonomic group (AUD, 2023)	No. (Aus) EPBC Act-Listed Species	Estimated total expenditure to recover EPBC Act-listed species by mean (AUD, 2023)	Estimated total expenditure to recover EPBC Act-listed species by median (AUD, 2023)
Reptiles	7	$5,892,958	$6,355,639	9	$53,036,618	$57,200,751
Mammals	19	$4,035,184	$2,303,516	9	$36,316,656	$20,731,645
Fish	12	$4,208,916	$1,591,487	23	$96,805,075	$36,604,190
Birds	16	$1,748,314	$634,984	54	$94,408,976	$34,289,139
Total	54	$3,637,023	$809,896	95	**$280,567,325**	**$148,825,725**

DISCUSSION

We estimate that the cost of preventing near-term (<10 yr) extinction of 95 EPBC-listed Australian marine species is A$280.6m/yr (U$204.8m/yr), when computing estimates based on the average expenditure across four broad marine taxonomic groups in the USA, using 2023 constant pricing.

We were surprised at the relatively low average cost of marine mammal conservation in the USA that led to lower-than-expected (A$4.0m/species/yr) estimates of conservation cost, particularly considering the challenges associated with cetacean conservation and monitoring. We tried separating cetaceans from other marine mammals in our analysis and found it made no difference (in fact, cetaceans received on average slightly lower expenditure than other marine mammals). One possible reason for the lower-than-anticipated cost of cetacean conservation to the US government may be the relatively large contribution that private conservation organisations make in conserving the species. The question this raises in the Australian context is whether it is reasonable to assume that private conservation organisations will subsidise government (lack of) expenditure in Australia. Given the differences in philanthropy culture between Australia (0.8% of GDP) and the US (2.1% of GDP) (Philanthropy Australia 2021), this assumption may not hold in the Australian context, making the need for appropriate government funding even more essential to the survival of these species.

Our approach to estimating necessary expenditure to conserve threatened marine species is intended as a thoughtful first pass, pending the compilation of more detailed species-specific estimates of conservation costs from species experts, or ideally, up-to-date government sources. While we urge that such data be compiled and analysed as soon as possible, we believe that our work provides a good starting point, from which the nuances of species

biology and relevant threats can be used to fine-tune conservation cost estimates. Recovery planning processes in the United States provide useful guidance on how protection and recovery costs should be computed and reported (e.g., NOAA Fisheries 2020). There are similarities that will make the conservation costs roughly equivalent between the two countries e.g., federalized policy requirements, land area, per-capita wealth, labor costs; but further work on expenditure compilation should, where possible, begin to account for the country-specific differences, in order to get a more detailed picture of adequate recovery costs, e.g., Australia has ~20% more coastal area than the US, far lower population density, and lower GDP.

So far, we have focused on the estimate of conservation funding needed based on the average USA expenditure across species within a taxonomic group. If median USA expenditure is used, the estimate of funding required to secure and stabilize Australia's threatened marine animals is reduced by approximately half to A$148.8m/yr. That is because a few species in each taxonomic group receive much higher levels of funding than most other species. We recommend using the result based on average expenditures because, as in the USA, there will be a few Australian species that are significantly more expensive to manage and protect than others. For example, for species such as turtles where effective conservation is likely to involve protecting significant areas of nesting habitat from egg predation by feral pigs and other invasive species, the conservation measures required may be very expensive compared with the protection or recovery needs of other marine reptiles such as sea snakes.

In this paper, we have used benefit transfer as the methodology for calculating costs of recovering threatened species. Benefit transfer is a blunt tool and can be critiqued on a number of fronts (Newbold et al. 2018; Rolfe et al. 2015b); in our case, much of its reliability depends on how similar the species, threats, recovery methods, and institutional contexts are. The US ESA expenditure reports are a relatively good contextual match for the Australian conditions – as mentioned above, both countries have a similar level of *per-capita* wealth, administrative responsibility for threatened species, judicial systems, prominent roles in global marine diplomacy, and history of public environmental spending (Wintle et al. 2019). As such, while benefit transfer has its shortcomings, without existing conservation expenditure data for Australia, these methods are among the most appropriate for deriving an estimate of required spending (Rolfe et al. 2015b). Currently, there is no easily accessible compilation of data on how much the Australian federal and state governments invest in individual species recovery. Failure to collect and compile such data contributes to a lack of transparency and government accountability that has been addressed in the United States and should be addressed in Australia as a matter of urgency. Without transparent and readily available conservation expenditure data, the Australian government is ill-equipped to know how much and where to spend funds to avoid the irreversible effects of biodiversity loss and meet national policy and global agreement commitments. At present, we do not have a national body nor data resource that is systematically analysing government and non-government conservation efforts to understand what is and is not working, and to refine and improve our collective conservation policy and action effectiveness and efficiency.

Australia is a member of the High Level Panel for a Sustainable Ocean Economy and has committed to "... sustainably manage 100% of the ocean area under national jurisdiction, guided by Sustainable Ocean Plans, by 2025" (High Level Panel for a Sustainable Ocean Economy (Ocean Panel), 2023). Implementing and reporting on globally ratified obligations to prevent the extinction of species in oceans under Australian jurisdiction will strengthen Australia's leadership in sustainable ocean management and support Australia's progress toward GBF Targets (Wentworth 2024).

Our estimates of the funding needed for Australia to prevent the near-term extinction of its listed threatened marine species are to be considered a minimum spending floor. We have not here collated what the Australian Government is *currently* spending on threatened marine species, and therefore the funding gap itself is unknown. Given the lack of recovery progress on Australian threatened species, and the known correlation between spending and improved conservation outcomes (Waldron et al. 2017), it seems likely that the gap is very real. We encourage the Australian government and other jurisdictions to transparently document species protection and conservation funding according to the precedent set by the USFWS. We encourage the Australian government to include rigorously computed recovery cost estimates in legally binding recovery plans when species are listed as threatened under environment protection laws. And we encourage the adequate funding of these endeavours. These measures will help progress Goal D and Targets 19 and 21 of the Global Biodiversity Framework that pertain to increasing funding and ensuring that knowledge is available and accessible to guide biodiversity action.

SUPPLEMENTARY MATERIAL

The following link will provide access to spreadsheet calculations, Supplementary Material Tables 1−9:

https://docs.google.com/spreadsheets/d/10MLzPvF3yDk0rkDk3qHhJjMLebtoB2y0/edit?usp=sharing&ouid=114757856489774410186&rtpof=true&sd=true

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