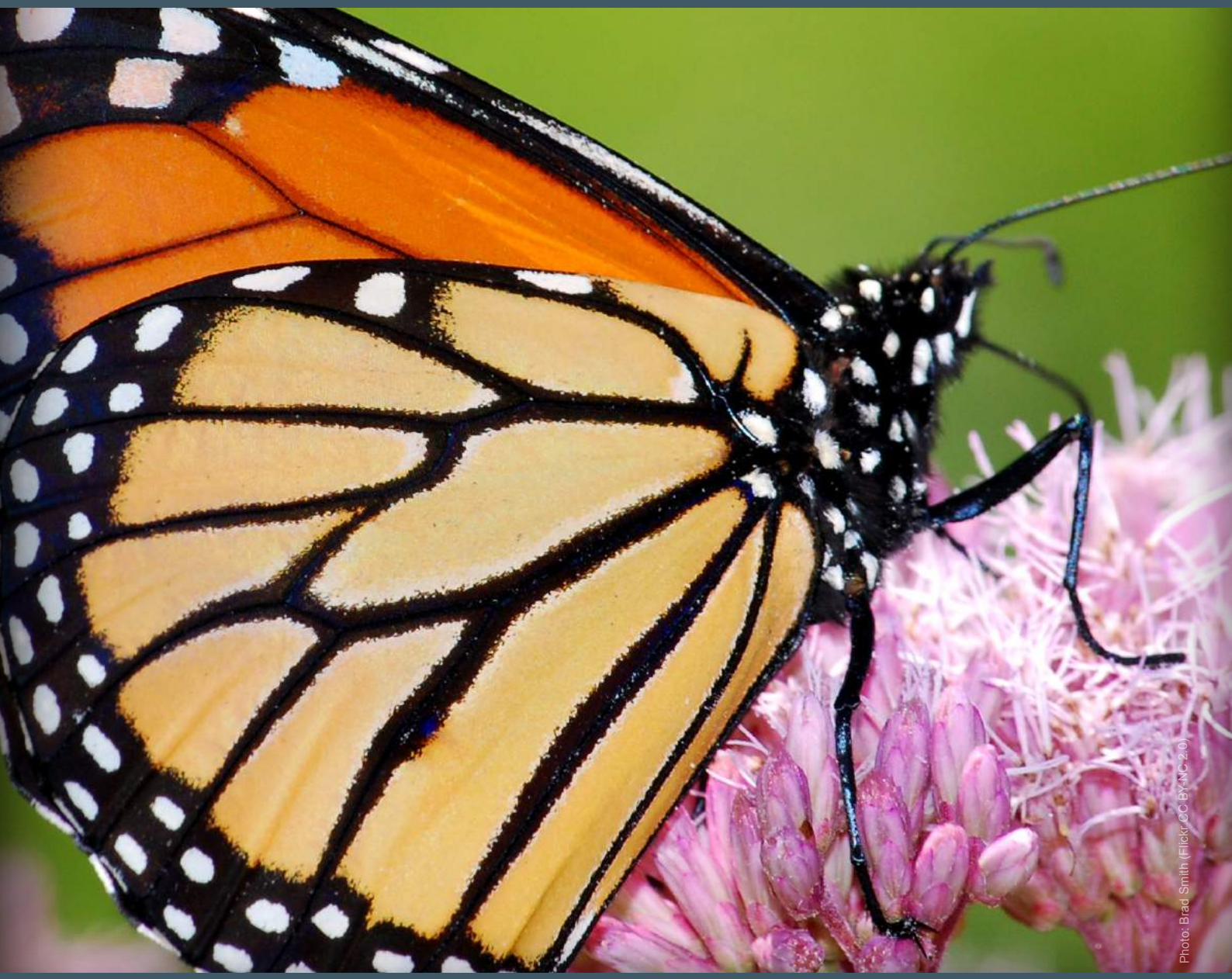
Threatened Species Recovery Hub

National Environmental Science Programme



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A review of non-market valuation studies of threatened species and ecological communities

Report to the National Environmental Science Programme, Department of Environment, Canberra.

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A review of non-market valuation studies of threatened species and ecological communities

1. Abstract

Literature on non-market valuation (NMV) of threated species and threatened ecological communities was collated and reviewed. We reviewed 76 papers, of which seven were from Australia. There is strong evidence that the broader community does support and is willing to pay for protection and recovery of threatened species. In many cases, the estimated non-market values far exceed the expenditure that would be required to protect or recover the species. However, there are significant gaps in the literature, particularly for threatened reptiles, plants, insects and non-charismatic species. There are no NMV studies of threatened ecological communities. We identify cases where evidence about non-market values has had a notable impact on the management or funding of threatened species. There are many such cases. However, overall utilisation of NMVs in decision making about threatened species is low and there is great potential for benefits if its utilisation is increased. Barriers inhibiting such an increase include lack of awareness of economics in relevant organisations, lack of existing economics capacity in those organisations, the limited volume of existing evidence about NMVs for threatened species and ecological communities, and a lack of time and resources to undertake economic analysis. We make suggestions for future directions for research and capacity-building.

2. Introduction

Threatened species and ecological communities provide tangible and intangible economic benefits to society, including provisioning services, regulating services and cultural services (Innes and Frisvold, 2009). Economic activities in ecologically sensitive areas often affect these species and communities negatively. When plans or policy decisions are being made in relation to these economic activities, it is important to be able to consider the resulting impacts on threatened species and ecological communities. Ideally, these impacts would be quantified in a way that allows direct comparisons between benefits and costs of different types. That is why environmental economists are interested in quantifying environmental impacts (including impacts on threatened species and ecological communities) in dollar terms.

The values associated with threatened species and communities are difficult to estimate because they are generally not bought and sold in markets, with the result that we cannot observe the prices that people are willing to pay. To address this, economists have developed a number of non-market valuation (NMV) methods. These methods derive values either indirectly through market behaviour (revealed preference approaches) or directly through surveys of relevant populations (stated-preference approaches). The key revealed preference approaches are known as hedonic pricing and the travel-cost method, while the key stated-preference approaches are contingent valuation (CV) and choice experiments (CE), also known as choice modelling.

More recently, attention has been growing on the technique of benefit transfer, where non-market values estimated in an earlier study for a particular environmental asset in a particular context are transferred to a similar asset in a new context or policy setting. This is gradually gaining acceptance as methods are refined, increasing the legitimacy of the approach (Baker and Ruting, 2014). The key benefit of benefit transfer is the saving in cost relative to an original NMV study.

While non-market valuation of the environment has become increasingly sophisticated, efforts to institutionalise the findings of these studies appear to have proceeded more slowly (Baker and Ruting, 2014; Rogers et al. 2015). On the other hand, this situation is by no means unique to non-market valuation. Methodologies for linking research to policy practice are poorly developed generally and the difficulties of doing so have been engaging research funders for decades.

This report provides a review of studies that estimate non-market values for threatened species and ecological communities with an emphasis on types of species or communities studied, techniques used, values estimated and their domain of application. We also provide evidence on the uptake of NMV research findings in decision making contexts, and the gaps or limitations on their use. In the following sections, we outline methods, results, gaps, and policy impacts.

3. Methods

We conducted a systematic desktop study to document non-market valuation studies of threatened species and ecological communities, and their application in policy and practice.

During July and August 2015 we searched three databases (Scopus, Web of Science and Google Scholar) for relevant non-market valuation studies using a range of key words, including "non-market value", "non-market valuation", "willingness to pay", "contingent valuation", "economic value", "valuation", "endangered", "threatened", "species" and "ecological community".

We also searched the web for references to published studies outside the professionally published scientific literature to determine how studies of non-market valuation had been applied. This included reports, policy documents, advocacy literature, web sites and blogs. While such searches aimed to identify direct links to the focal study, some searches also located additional valuation studies of the same species. The ways in which these studies were applied were also considered. The web searches also identified institutional applications of non-market valuation in non-Australian jurisdictions.

We also wrote to the senior authors of those studies to ask how they felt their study had influenced policy or practice at the sites where they were working or elsewhere. This aimed to identify applications that may not have been apparent from web searches.

We developed a typology of impact, drawing heavily on the Economic and Social Research Council UK (http://www.esrc.ac.uk/research/evaluation-and-impact/what-is-impact/), and we attempted to categorise each of the original studies based on the data collected as well as the institutional applications identified in web searches. Lastly we synthesized the findings and identified gaps for future research.

4. Results and key findings

4.1 Number of studies

The number of studies examining the value of threatened species and ecological communities vary depending on key words used and the database considered. For the purpose of this review, we considered the key words listed in Table 1 (Column 1) to explore numbers of hits in three different databases. Table 1 shows the results of our literature search.

Table 1. Number of unique hits by database and keywords (as of 25 August 2015).

	Database					
	Google Scholar		Scopus			Web of Science
Keywords used	Any-where	In title	Title, keyword, abstract	Title	Keyword	Topic
"species valuation" and "economic"	416	1	4	0	1	2
"wildlife valuation" and "economic"	405	3	2	0	0	1
"habitat valuation" and "economic"	114	1	6	0	2	3
"threatened species valuation" and "economic"	1	0	0	0	0	0
"economic valuation" and "species"	20,000	26	132	3	17	120
"threatened species" and "economic valuation"	1870	0	2	0	0	3

After examining the search results, we decided to explore the number of hits generated by the keywords - "economic valuation" and "species". We considered the number of studies that lists these keywords either in the title or abstract or the keywords section of the articles but not anywhere (Google Scholar). The Scopus search produced the highest number of relevant peer-reviewed literature while the Google Scholar search produced some relevant grey literature. Some studies were obtained from citations in other papers as well as from the meta-analysis publication of CV studies by (Richardson and Loomis, 2009). We examined the abstract of all these studies. A total of 106 studies were found relevant for further consideration. Among 106 studies, some were either theoretical or methodological or focused on valuing ecosystem services rather than species. Finally, a total of 76 studies were found closely related to our purpose and selected for in depth review. Appendix -1 tabulates these studies with additional details.

4.2 Coverage of studies

Geography

Geographically, nearly all non-market valuations of species (92%) were concentrated in developed counties (Table 2) with just six based on data from developing and newly industrialized countries (Brazil, China, India, Kenya, South Africa and Sri Lanka). Among the developed countries, 31 (41%) of all selected studies (Table 1) were conducted in the United States followed by nine in the United Kingdom (12%) and seven in Australia (9%). Australian studies reviewed were Jakobsson and Dragun (2001), Tisdell et al. (2005), Wilson & Tisdell (2006), Tisdell & Wilson (2006), Tisdell & Nantha (2007), Tisdell et al. (2007), and Zander et al. (2014).

Table 2. Geographical distribution of studies (n=76)

Country	Number of studies	Country	Number of studies
USA	31	Brazil	1
UK	9	China	1
Australia	7	Ireland	1
Spain	4	India	1
Sweden	3	Japan	1
Canada	3	Kenya	1
Greece	3	Netherlands	1
South Korea	3	New Zealand	1
Israel	2	South Africa	1
		Sri Lanka	1

Non-market values methods and data collection techniques

Based on the method(s) used, reviewed studies were divided into five groups as follows:

- 61 studies used contingent valuation method (CV)
- 12 studies used choice experiments (CE)
- 3 studies used travel cost method (TCM)
- 2 studies used both CV and TCM and one study has used CV and CE
- 2 studies used the Benefit Transfer method

Methodologically, CV has been the main approach used in the studies on threatened species and endangered communities. Most of the Australian studies have applied this method.

Among CV studies, over half (54%) used the single-bounded Dichotomous Choice (DC) approach, followed by Open Ended (OE) designs (26%), the Payment Cards (PC; 16%) and Multiple Bounded Dichotomous Choice (MBDC) questions (8%). Some studies used multiple formats to examine the effect of question format on Willingness-To-Pay (WTP) values (e.g. Reaves et al., 1999, Tanguay et al., 1992).

These studies have used a variety of techniques to collect information. Of the 76 studies, 42% mailed surveys to respondents, 41% used face-to-face interviews, seven used online surveys, four conducted telephone interviews and one each used the television and the drop-off/pick-up approach to collect data. The 32 mail surveys and 31 face to face studies include three studies that have used both techniques to elicit responses.

Type of species valued

Most valuation studies were focused on mammals and other charismatic and flagship species such as bald eagles (*Haliaeetus leucocephalus*) or loggerhead sea turtles (*Caretta caretta*). The only study valuing insects (Diffendorfer et al., 2014), also focused on a charismatic species - the monarch butterfly (*Danaus plexippus*). No study considered ecological communities.

- 42 of the 76 studies valued mammals. Seven of the 42 assessed the economic worth of mammalian species along with species belonging to other classes such as birds and reptiles.
- Birds were the second most widely studied class with 26 studies, of which 19 evaluated their benefits exclusively and seven did so along with species from other classes.
- 14 studies valued fish, of which seven assessed their worth together with species from other classes.
- Seven studies assessed the benefits of reptiles of which only two focussed exclusively on the reptilian class while the other 5 included mammal, birds, fish and plant species.
- Two studies evaluated the economic benefits of crustaceans, one of them along with a fish species (Ojea and Loureiro, 2010, Stanley, 2005).
- Only one study (Mitani et al., 2008) exclusively focused on plants - fringed water lily in Japan; but three other studies - Giraud et al. (1999), Loomis and Ekstrand (1997) and Yao et al. (2014) - considered plants along with other species classes.
- Only one study assessed the non-market value of an insect (Diffendorfer et al., 2014).

Most studies focused on calculating the economic value of a single species but 23 studies were designed to study the economic benefits of several species all at once – either from the same class or a different class. For example, Boxall et al. (2012) computed WTP estimates for the recovery of three marine mammals – the beluga whale, the blue whale and the harbor seal that were indicators of the health of the St. Lawrence Estuary in Canada. Yao et al. (2014) studied the enhancement of biodiversity from four different classes – birds, fish, reptiles and plants, in planted forests in New Zealand. The valuation studies by Tisdell and Wilson (2006) and Tisdell et al. (2007) included the most number of species studied together (24) in Australia to determine how respondents' WTP changed when they are provided with more information on the endangerment of individual species from different classes. Giraud et al. (1999) assessed the sensitivity to scope/scale in the difference in willingness to pay (WTP) responses for one endangered species – the Mexican spotted owl (*Strix occidentalis lucida*) as a subset of 61 other threatened and endangered species in New Mexico, USA.

Magnitudes of non-market values

The non-market values of threatened species and ecological communities vary considerably based on species valuated and the sample population. The estimated non-market values of various threatened species are given in Appendix 1. Value estimates from the two meta-analyses (Loomis and White 1996; Richardson and Loomis 2009). Some relevant findings from international studies, such as reasons for willingness to pay and factors that influence WTP, are also discussed. (Dollar values in the following examples are US$.)

- Loomis and White (1996) conducted a meta-analysis of CV studies conducted in the US during the 1980s and 1990s. It included the non-market values of 18 rare and endangered species. They found that the willingness to pay ranges from $6/household/year for Striped Shiner to $95/household/year for the Northern Spotted Owl and its old growth habitat in 1993 U.S. dollars ($9.90 to $156.35/household/year in 2015 U.S. dollars).
- Richardson and Loomis (2009) conducted an updated meta-analysis covering 31 studies. They found that the non-market values of species in the US are sensitive to changes in the size of species population, the types of species being valued, and whether visitors or local households are valuing the species. They found that the WTP ranged from $8/household/year on average to a maximum of $311/household/year for Washington State anadromous fish populations. In the same study, they compared lump-sum WTPs for some studies, suggesting a low WTP value of $20 for Arctic grayling and a high WTP value of $350 for Bald eagle (all values in 2006 U.S dollars).
- Non-use values, especially the existence value of a species, was a major reason for respondents' WTP for species conservation (Hageman, 1985, Kontogianni et al., 2012, Kontoleon and Swanson, 2003, Stevens et al., 1991). Existence value is the "value derived from the knowledge that the species exists and will continue to exist irrespective of the any current or possible future use of the species" (Jakobsson and Dragun, 1996). This was a major factor even for species with considerable use value such as the endangered Asian elephant (*Elephas maximus*) (Bandara and Tisdell, 2003). Other studies found that altruistic/bequest values – the satisfaction that people derive from knowing that others/future generations can also enjoy the benefits of a particular species – was a major factor in people's WTP for species' conservation (Jin et al., 2008, Kotchen and Reiling, 2000, Langford et al., 2001).
- WTP was generally found to be positively correlated with higher income, higher education level, lower age and a stronger pro-environmental attitude (Ericsson et al., 2007, Hakansson et al., 2011, Kotchen and Reiling, 2000, Mitani et al., 2008, Jin et al., 2008). In some cases gender was an important criterion with females having higher WTP than males in some studies (Ericsson et al., 2007, Mitani et al., 2008) and the reverse being true in others (Montgomery and Helvoigt, 2006).
- In certain cases WTP values were found to be negatively correlated with proximity to the location of the species' habitat, especially for large carnivores. Chambers and Whitehead (2003) and Ericsson et al. (2007, 2008) found that respondents living close to the habitat of large carnivores (wolves, wolverines, bears and lynx) were less likely to support conservation efforts compared to people living in urban areas away from carnivores.
- Many studies found that non-market values were sensitive to population size. Marginal WTP often decreased when populations increased above their minimum viable population sizes, consistent with commonly observed result of diminishing marginal utility with increasing consumption of a good (Bandara and Tisdell, 2005, Bulte and Van Kooten, 1999, Bulte and van Kooten, 2002, Lew et al., 2010, Loomis and Larson, 1994, Ojea and Loureiro, 2010).
- WTP has been found to be higher for CV surveys using a dichotomous choice approach than an open ended format (Richardson and Loomis, 2011, Tanguay et al., 1992). For example, mean WTP values determined by Tanguay et al. (1992) for Woodland Caribou conservation were $18.10/person/year using an open ended format and $39.90/person/year using a dichotomous choice format. Similarly, Reaves et al. (1999) determined the mean WTP for the Red-cockaded Woodpecker to be $14.25/person/year and $17.40/person/year using the open ended and the dichotomous choice formats respectively.
- Split sample surveys demonstrated a sensitivity of WTP values to scope. WTP was found to be higher for a collection of threatened species valued as a whole versus a single species that was part of the group and valued individually (Giraud et al., 1999, Loomis and Ekstrand, 1997, Stanley, 2005). This is in agreement with economic theory

that WTP for any good is "significantly higher for a comprehensive good than a subset of the good" (Giraud et al., 1999). On the other hand, when the researchers used an internal scope test (not a split sample design), WTP for a single species did not differ from that for a collection of species (Giraud et al., 1999).

- The importance of information disclosure was demonstrated in several studies. WTP was strongly and positively correlated with the amount of information about the species provided to respondents. (Samples et al., 1986, Tkac, 1998, Wilson and Tisdell, 2007). This was especially true for unfamiliar species and was demonstrated through several studies by Tisdell et al. in Brisbane, Australia, which are described in greater detail below.
- The importance of the endangerment status of a species over its likeability was also demonstrated by Samples et al. (1986) through an experiment involving 240 participants who were asked to allocate a hypothetical lump sum amount of $30 among three species A, B and C for different scenarios where information about the species including species type and endangerment level was gradually revealed to them.
- Richardson and Loomis (2011) found that, for nationally symbolic species, people in developing countries were willing to pay more as a percent of their income than people from developed countries even though the absolute WTP estimates from developed countries were higher. As examples, they cite Bandara and Tisdell (2004)'s paper where the Sri Lankan respondents' WTP values for Asian Elephant conservation of $17.10-$20.65/household/year is 1% of total annual income of about $1911. Ninan and Sathyapalan (2005) estimated WTP values for Asian elephant conservation in terms of time (foregone income) in a coffee-growing region in the Western Ghats of India and found that the economic worth of the elephant varied between $71 and $165/household annually which represented about 10% of the respondents' income. However, as Richardson and Loomis (2011) noted, this value was elicited as opportunity cost of time and was therefore, less constrained than if the value had been elicited in monetary terms. However, Jin et al. (2008) valued the black-faced spoonbill in Macao, China, and found that the mean WTP was much less - only about 0.2% of the annual income of respondents. This, nonetheless, was still higher than US studies valuing the bald eagle where the WTP amount was only between 0.05-0.07 percent of the respondents' annual income.

The following seven studies relate specifically to Australia.

- Jakobsson & Dragun (2001) studied the Leadbeater's possum (*Gymnobelideus leadbeateri*) in Victoria, Australia as a part of the response to funding to endangered species conservation program. Based on conservative estimates, the results indicated that the value of endangered species was at least two to three fold that of the conservation expenditure at state level. At the time of survey (1986), there were 2.89 million individuals and 1.36 million households in Victoria. The extrapolated mean estimates – which were considered conservative – indicated a value of AU$40 million/year (AU$29 /household) for Leadbeater's possum and AU$160 million/year ($118/household) for endangered flora and fauna. These values were considerably larger than the actual expenditure on species conservation at the time of the study (about AU$10 million)/year). The value of Leadbeater's possum was found to be three times the value generated from timber.
- Zander et al. (2014) conducted a CV study to explore funding support for threatened bird conservation in Australia and found that two thirds of the respondents (n=645) were willing to pay into a fund for bird conservation. On average, each respondent was willing to pay AU$11/year which is the equivalent of a conservative WTP estimate of AU$14 million/year for threatened Australian birds when extrapolated to the Australian population as a whole.

- Tisdell has studied the economic value of a number of threated species in Australia. Tisdell, Wilson and Nantha (2005) studied the non-use value of endangered mahogany gliders through three consecutive CV surveys among 204 Brisbane residents. The surveys were used to estimate the willingness to pay to maintain a viable glider population and its habitat for 100 years. Results suggest that, on average, the respondents were willing to pay one-off donations to conserve the glider at a range of AU$25 to AU$36 among different surveys. Extrapolating the sample estimate of the value of glider conservation to Brisbane, Queensland and Australian populations gave an aggregate WTP to conserve glider at an order of AU$30 million, AU$70.25 million, and AU377 million, respectively.
- Using the 204 sample of Brisbane residents, Tisdell, Nantha and Wilson (2007) studied the relative influence of the degree of species endangerment and stated likeability on an individual's allocation of funds to conserve the species. They used two serial surveys to assess 24 Australian wildlife species (mammals, birds, and reptiles) by providing additional information on focal species between the surveys. Their results suggest that the public's allocation of funds to conserve wildlife species is more sensitive to information about the conservation status of species than to factors influencing their charisma/likeability.
- Tisdell and Nantha (2007) also examined the willingness to pay to conserve two species of wildlife among 204 Brisbane residents using two surveys. They found that the weekly WTP of Brisbane residents to conserve the species range from AU$1.73 to AU$1.94 for Northern-hairy nosed wombat and AU$1.40 to AU$1.45 for Koala, respectively for the first and second surveys. Based on the same survey, Tisdell & Wilson (2006) also found that the respondent's willingness to allocate funds to conserve species were not related to their economic values but to the policy context, suggesting that a poorly known species in remote areas may obtain much less conservation support than they deserve.
- Wilson & Tisdell (2007) studied how knowledge affects payment to conserve endangered golden-shouldered parrots in Australia using survey responses from 204 Brisbane residents. This study aimed to examine the impact of information provided between two surveys and relative knowledge of other common bird species on willingness to allocate funds to conserve three Australian tropical species: Golden-shouldered parrot, Tree Kangaroo and Hawksbill Turtle. Average willingness to pays among residents before (after) providing information were about AU$72.8 (AU$75.40), AU$98.96 (AU$74.36), and AU$81.64 (AU$70.72) per year for Golden shouldered parrot, Tree Kangaroo and Hawksbill Turtle, respectively. The results suggest that information played a role in the allocation of funds to conserve species. For example, in the case of Golden-shouldered Parrot fund allocation increased from 10.87% of a given budget (say AU$1000) to 15.3% after the information was provided.
- Tisdell has conducted a number of non-market valuation studies on threatened species in Australia. He believes that, while these studies have increased awareness among ordinary citizens and policy makers, the findings have not directly influenced environmental policies in Australia (Clem Tisdell, pers. comm.). He also maintains that rarity and the probability of extinction has a much greater influence on WTP than other factors that he and his colleagues investigated.

4.3 Application of benefit transfer approach

Only two studies have examined benefit transfer as a method to estimate the value of threatened species. Loomis (2006) estimated recreation and existence values of the southern sea otter (*Enhydra lutris nereis*) expansion along the Santa Barbara coast in the US using two methods (a) benefit transfer derived from an existing sea otter CV study (Hageman, 1985), and (b) a benefit transfer function derived from the meta-analysis of Loomis and White (1996). The WTP for an increase in the sea otter population over 10

years was calculated to be $1.40/ household/year using estimates from Hageman's (1985) study, while it was $5.81/household/year and $2.32/household/year using the linear and log model estimates from the meta-analysis. This translates into an aggregate WTP of $16.1 million, $66.8 million and $26.7 million for all 11.5 million California households for the estimates from the Hageman (1985) study, meta-analysis linear model and meta-analysis log model respectively. (All values are in 2002 U.S $).

A Benefit Transfer approach was also used to value three threatened species in Brazil for which no previous economic valuation surveys had been carried out (Cardoso de Mendonça et al., 2003). The authors used the meta-analysis by Loomis and White (1996) to estimate the upper and lower bounds for WTP, and used it to develop a benefit transfer function that converted the WTP estimates from the US dollars to Brazilian Real. The upper and lower bounds of WTP for the black lion tamarin, golden lion tamarin and woolly mouse opossum was then estimated from the WTP in Brazilian Reals by multiplying by the weight of genetic distinctiveness of each species (based on the taxonomic tree) as well as by the estimated probability of persistence of each species as calculated through population viability analysis. The range of value estimates that resulted was wide (e.g. $4.35 -$149.90/household/year for Black Lion Tamarin). Although the WTP values were sensitive to the assumptions made and parameters used in modelling, using the lower bounds of WTP, they found that the total amount actually spent in Brazil for the three species (about $135 million from 1985 to 1996), was below the aggregate WTP of about $440 million ($10/household). No studies have been undertaken in Australia that use benefit transfer to assess values of local threatened species.

4.4 Research gaps

The literature on NMV of threatened species is moderate in size, but it is focused in particular areas, leaving clear knowledge gaps.

Loomis and White (1996) noted that, due to both ecological complementarity among species and substitution effects (utility function and budget constraints), a habitat-based approach could be more useful than valuation of individual species for calculating the non-monetary values of rare and threatened species. Two decades after this suggestion, we could find no studies focusing on habitat or ecological communities.

Almost all existing studies focused on animals. We found just one study focussing exclusively on plants, and three others that included plants as part of their research.

Within the studies of animals, most were for mammals (42 of the 76 studies). For both mammals and non-mammals, most NMV studies were of charismatic species.

Within the animals NMV studies, there was only one study of an insect (Diffendorfer et al., 2014). Not surprisingly, this was a charismatic species: the monarch butterfly (*Danaus plexippus*).

Valuation studies for flora and fauna that are either unfamiliar to people or are not charismatic may help understand the full range of WTP among the broader population. On the other hand, the relevance and reliability of non-market valuation studies on species that are unfamiliar to people has been questioned.

Impact of non-market valuation of threatened species

Research impact can be defined as the "an effect on, change or benefit to the economy, society, culture, public policy or services, health, the environment or quality of life,

beyond academia" (REF 2014). While there are other definitions, alternatives to the word 'impact' such as 'returns', 'benefits' and 'value' all encompass the same issue about the sort of difference made by research and the extent of that difference (The SROI Network 2012). Understanding and quantifying this impact of research is extremely complex and has been the subject of major initiatives in many jurisdictions (e.g. Bornmann 2013; Higher Education Funding Council of England 2015). This is because research can have an impact that is often far broader than the field within which the research is undertaken, can take decades to be fully appreciated and is diffuse, with each new element of knowledge contributing to further knowledge, policy and societal change in ways that are difficult to understand let alone quantify (Grant et al. 2010). There may or may not be a direct link between problem, research, knowledge, application of knowledge and solution to the problem.

In this case, the institutionalisation of monetary measures of economic value has meant that a powerful array of measures of economic performance has been developed leading to a correspondingly substantial investment in the collection of the data they require. Such institutionalisation has grown out of centuries of history in which economic development took precedence over most social and nearly all environmental considerations. The growing realisation that economic growth is underpinned by a functioning environment and a stable society is increasing interest in adding these aspects to the national accounts. However, although increasingly sophisticated, the science of measuring environmental and social values is still relatively young. This means that much of the effort has been in developing methods and refining results to ensure their validity for use in policy, rather than their actual application. Given that, even for a field as venerable and as applied as cardio-vascular research, it takes an average of 17 years between research funding and altered practice (Buxton 2011), identifying impacts of the relatively new approaches to non-market valuation is difficult.

Notwithstanding such constraints, we have made a preliminary attempt to identify impacts using the impact typology we have developed.

4.5 Typology of impact

In keeping with the definition of research impact of the Australian Research Council, that 'research impact is the demonstrable contribution that research makes to the economy, society, culture, national security, public policy or services, health, the environment, or quality of life, beyond contributions to academia' (http://www.arc.gov.au/research-impact-principles-and-framework), this element our study concentrates on economic and societal impact.

The Economic and Social Research Council UK (ESRC; http://www.esrc.ac.uk/research/evaluation-and-impact/what-is-impact/) provides the most relevant typology for assessing the impact of research on the non-market values of threatened species. The Council divides research impact into:

- academic impact: the demonstrable contribution that excellent social and economic research makes to scientific advances, across and within disciplines, including significant advances in understanding, methods, theories and applications; and
- economic and societal impact: the demonstrable contribution that excellent social and economic research makes to society and the economy, of benefit to individuals, organisations and nations.

To help understand impact, the ESRC also divides impact into three subclasses

- Conceptual: contributing to the understanding of policy issues, reframing debates; and
- Instrumental: influencing the development of policy, practice or service provision, shaping legislation, altering behaviour;
- Capacity building: technical and personal skill development.

In the first class of impact we placed impacts related to advocacy, either to create new policies or practices or to reinforce existing ones. Given the relative novelty of articulating non-market values, the influence of research on advocacy has played an important role in having the approaches accepted, at least outside Australia.

In the second class we have included impacts arising from research that aims to calculate compensation or rewards relating to non-market values where there are trade-offs with other values and research that is related directly to legislation and regulations. This includes non-market valuation that has had a direct impact on policy or is required as part of regulatory impact assessment.

In relation to capacity building, none the reviewed NMV studies had an explicit focus on capacity. However, there have been other initiatives that have attempted to build capacity that are relevant to NMV. We will briefly outline two of these.

Using this typology, the following examples serve to illustrate the ways in which NMV research can have impact.

4.6 Conceptual impacts: Advocacy

One of the most common applications of non-market valuation of threatened species is advocacy. These studies usually allude to the failure to account for non-market values of threatened species when developing policy. As a result, such studies argue, policy either fails to provide appropriate levels of protection or sufficient resources to implement protective measures. Advocacy tends to have one of two aims – either to change existing policy or to reinforce it.

Advocacy: Change existing policy
Examples of advocacy to change existing policy include the following:

A study of the non-market values of wolves in Minnesota (Chambers and Whitehead 2003) is one of a number on wolf economics in the lower 48 states. These studies are part of the argument presented by the NGO Defenders of Wildlife as a reason for conserving wolves (http://www.defenders.org/places-for-wolves/economic-benefits-wolves). They are also presented by the Department of Natural Resources in Minnesota as a reason for conserving wolves in that State (http://www.dnr.state.mn.us/mammals/wolves/mgmt.html).

Also in the USA, the study by Diffendorfer et al. (2013) (reporting that Americans would be willing to donate $6.5 billion out of their own resources to support milkweed restoration and monarch butterfly conservation) was listed among the "15 most significant initiatives positively affecting monarch butterflies since 2013's National Pollinator Week" (http://makewayformonarchs.org/i/archives/1369 - sthash.hpKD0All.dpuf). The research was reported extensively in US media and appears to have been used in arguments to obtain extra funding for the monarch as well as to support international agreements between the USA, Mexico and Canada on monarch conservation.

Similarly a study of otters and voles in England (White et al. 1997) is still being used to promote fox conservation (http://www.thefoxwebsite.net/After-the-Hunt.pdf) 18 years after publication of the original paper.

Advocacy: Retaining existing policy

An example of where non-market valuation has contributed to maintenance of existing policy is the study by Becker et al. (2005) who used the travel-cost method to calculate the monetary benefits delivered to people visiting the feeding site for Griffon Vultures on the Israeli-Syrian border. Becker (*in. litt*.) is convinced that the study was one reason that the practice of feeding the vultures continued.

4.7 Instrumental impacts

Instrumental: Damage assessment or compensation

Direct reports of willingness-to-pay and other evaluative studies being used to calculate monetary compensation are surprisingly rare. Bosetti and Pearce (2003) calculated the amount of compensation that fishermen were at that time willing to accept for seal damage in England and, in correspondence, Valentina Bosetti stated that "I am almost positive the Cornwall government decided to pass some sort of small fee for seal protection that aimed at compensating fishermen".

Table 3. Regulatory mechanisms by which values of regulatory actions are measured and considered in decision making in developed countries.

Country	Key elements of RIA	Key Considerations	Source
USA	Quantify and monetise the benefits and costs of proposed regulatory action and its alternatives. Considers both use and non-use values. Emphasise revealed preference approach where possible	WTP, WTA, Health effects, Value of Statistical Life (VSL)	https://www.whitehouse.gov/sites/default/files/omb/inforeg/regpol/circular-a-4_regulatory-impact-analysis-a-primer.pdf
Canada	Estimate the benefits and costs using willingness to pay or willingness to accept. Example cases include: to improve human health, to avoid getting hurt, to obtain an environmental improvement or to preserve natural resources.	WTP, WTA	http://www.tbs-sct.gc.ca/rtrap-parfa/temp-gabar/mhitrias-gimereir-eng.asp
New Zealand	Focus on full cost-benefit analysis where applicable with detailed option and risk analysis for each option. Considers equity issues (who wins and who loses).	CBA (NPV)	http://www.treasury.govt.nz/regulation/regulatoryproposal/ria/handbook
OECD	Focus on CBA, where C and B can't be easily available recommend survey type techniques.	CBA, WTP/WTA	http://www.oecd.org/gov/regulatory-policy/44789472.pdf
Australia	Focus on Cost-Benefit Analysis. Best Practice Regulation: A guide for Ministerial Councils and National Standard Setting Bodies (2014) requires the outcomes of a	CBA, distribution of costs and benefits, non-monetary values	https://www.dpmc.gov.au/office-best-practice-regulation

	range of options are translated into comparable terms in order to facilitate evaluation and decision-making. Considerations on distribution of benefits and costs as well as intangible values. The value of 'intangibles' need to be separately presented to decision makers in conjunction with CBA.

Instrumental: Setting fees

Pandit et al. (2015) conducted a CV study of international and domestic visitors' willingness to pay an entry fee at Chitwan National Park (CNP) in Nepal. As a result, entry fees were substantially increased, generating additional income for park management and for local communities.

An anecdotal example is that Aurelia Gomez recently completed research in which tourists climbing the highest mountain in the Philippines were asked how much they would be willing to pay for the conservation of biodiversity on the mountain. The fee for climbing the mountain was then raised by 30% as a direct result of her research (A.Gomez pers.comm.).

Instrumental: Legislation

Regulatory Impact Assessment is widely applied around the world (Table 3.). In many cases non-market analysis is a component of the impact analysis. In Canada RIA extends specifically to threatened species with Species at Risk Act, resulting in several studies that have then resulted in the conservation of habitat for threatened species. For instance the study by Boxall et al. (2012) was undertaken before gazetting a new marine protected area. The study identified that the non-market value of species using the protected area was greater than the direct use value by fishermen. Citing Forbes et al. (2015) study, Boxall states that "we have done I think four studies now on the existence value of threatened species that have played significant roles in developing recovery plans and/or have been need as part of a Benefit Cost Analysis in a listing decision" (P. Boxall pers. comm.). Additionally, Boxall also pointed out that the Zimmer et al. (2012) study on the 'impact of chronic Wasting Disease and its management on recreational hunters' was a component of the Benefit Cost Analysis of a wildlife management program. Similarly the study by Hagen et al. (1992) on the value of Spotted Owls was highly influential in the debate to conserve its habitat and that by Ekstrand and Loomis (1998) was used in calculating areas of Critical Habitat for fish species in the USA. Many such studies, however, remain unpublished but are undertaken under contract as part of regulatory requirements and are not made available on the web (P. Boxall pers.comm.).

4.8 Barriers to uptake of NMV results

Although the evidence in the previous sections show that uptake of NMV information has been influential in a number of cases, the uptake clearly falls well short of potential. Likely barriers to increasing the adoption of NMV results in environmental policy and management have been identified by Baker and Ruting (2014) and Rogers et al. (2015). Relevant factors include the following.

(1) The primary vehicle for use of NMVs in decision making would be in economic frameworks such as Benefit: Cost Analysis. However, environmental policy making often proceeds without considering relevant economic evidence. Indeed,

environmental decision makers often ignore basic economic concepts, such as costs (Wilson et al. 2007) and the with-versus-without principle (Maron et al. 2013). In these situations, there is no place for NMV to be formally integrated into the decision process. A sensible first step to overcome this problem would explicit support for the use of economic frameworks from senior officers in environmental agencies.

(2) A second (related) issue is a lack of awareness of economics and lack of capacity to apply economics in general and NMV in particular, in environmental decision making. Rogers et al. (2015) found that a large proportion of interviewed staff in environmental agencies and organisations were not aware of NMV and that around 50 per cent of the interviewed environmental decision-makers have never used any type of economic model. Seymour et al. (2008) found that most regional environmental bodies had little or no capacity in economic analysis. Key responses to this issue would include provision of training, identification of suitable economic tools that allow users integrate NMVs into a decision, and provision of support to users of those tools. An example of a relevant tool is INFFER (Pannell et al. 2012 – www.inffer.com.au), which was developed explicitly to facilitate and support the uptake of economics principles by environmental decision makers. Users of INFFER has access to detailed training and individual support.
(3) A third barrier may have been lack of a collection of the available evidence on NMVs of threatened species. This report helps to address that.
(4) There are specific gaps in evidence about NMVs, as outlined above. Filling these gaps could facilitate uptake of NMVs, although this seems less pressing than the other issues raised here.
(5) Lack of time and resources was mentioned by 29 per cent of respondents to Rogers et al. (2015). This includes lack of time due to competing demands, and lack of time due to rushed time frames for decision making. Strategies to address this could include: additional resources; longer time frames to prepare for new programs and policies; and development of simplified tools to facilitate benefit transfer.
(6) A perception of NMV researchers is that decision makers have philosophical objections to assigning monetary values to the environment (Rogers et al. 2015). However, in their interviews with potential users of NMV, Rogers et al. found that this is only a minor factor.
(7) Researchers also perceived that potential users have concerns about methodological limitations of NMV. While there are active debates within economics, Rogers et al. (2015) found that potential users are largely unaware of those debates or the issues they address.

4.9 Key findings and future research direction

Estimates of non-market values are employed both inside and outside government as instruments to ensure that environmental and social values are appropriately considered in policy and practice. On the other hand, many environmental decision makers who could benefit from utilisation of NMV results within an economic framework do not seek to utilise such results. In addition, many successfully completed NMV studies remain largely in the academic literature, without being provided to decision makers in a form that is relevant and usable. Some academic studies have contributed more to methodological refinement than to more immediate practical values. They do, however, often draw attention to the high non-market values of the matters they investigate, and this can influence thinking in subtle ways that are rarely articulated and difficult to quantify.

Key findings from this report are outlined below.

Firstly, there clearly is a role for utilisation of NMVs in decision making about threatened species. Australian Government (2007) encourages the use of non-market valuation for inclusion in Benefit: Cost Analyses of regulations. Baker and Ruting (2014) reach a number of relevant conclusions:

- "The evidence suggests that stated preference methods are able to provide valid estimates for use in environmental policy analysis.
- Because non-market valuation methods can generally provide objective estimate of the value that the community places on environmental outcomes, they offer advantages over other approaches to factoring these outcomes into policy analysis.
- The case for using non-market valuation varies according to circumstances. It is likely to be strongest where the financial or environmental stakes are high and there is potential for environmental outcomes to influence policy decisions.
- Where non-market valuation estimates are made they should generally be included in a cost–benefit analysis." (Baker and Ruting 2014, p. 2).

Secondly, there is a significant body of evidence on the non-market values associated with threatened species. We have summarised the evidence in this report, and provided details of each reviewed paper in Appendix 1.

Thirdly, there are important gaps and areas of relative neglect in the literature. These include:

- Australia. We identified only seven relevant studies for Australia. This is more than for most countries, but is still a modest number given the number and range of our threatened species.
- Classes of species. Most studies are for mammals. There is relative (and in some cases almost complete) neglect of threatened reptiles, plants, insects, and non-iconic or non-charismatic species.
- Ecological communities. There are no NMV studies of these.
- Benefit transfer. There are few studies internationally, and none in Australia, that have applied benefit transfer to threatened species.

Fourthly, there are various barriers that inhibit the greater utilisation of non-market values by environmental managers and policy makers. The barriers are well understood, and a number of them are readily addressable.

One of the purposes of this review was to identify possible directions for future research. Perhaps the most obvious direction is to undertake additional original studies to fill some of the identified gaps in knowledge about NMVs for particular types of species. This would facilitate improved decision making for these species, may support arguments for ongoing or increased funding, and would help to build a body of research results for benefit transfer.

However, if this was the only strategy, there is a high risk that utilisation of the resulting research would be inhibited by the barriers identified earlier. Therefore we suggest that research (and other measures) also be undertaken to address those barriers. Specifically, we suggest undertaking integrated economic analysis of threatened species management options to demonstrate how economics can inform decision making in this area, and how non-market values should be included in the process. This could include Benefit: Cost Analyses of specific options, or broader economic analysis that optimise across many options. An example of the latter is the trade-off between quality and quantity in threatened species management: Where should we lie on the spectrum between small amounts in many species versus large amounts in a few species?

We also see a need for approaches that will help to build capacity for economic thinking amongst environmental managers and policy officers. To further this, we suggest:

- Building Developing guidelines and training materials to raise capacity in relevant agencies and organisations. This may include adaptation of existing guidelines and materials (e.g. those for INFFER) to focus them on threatened species.
- Developing or adapting guidelines on benefit transfer. In most cases where NMVs are needed, the organisation does not have the resources to fund original studies, nor the time to wait for them. Although there is a shortage of Australian studies at this stage, it would be beneficial to start utilising benefit transfer based on local and international studies.
- Bringing economic thinking into the design of threatened species investments. The suggestion is to integrate the lessons from applying economic thinking to hundreds of different environmental projects, to develop insights and guidelines for the development of projects that will be as effective and cost-effective as possible.

We see these capacity building aspects as being crucial for building not just capacity but also support for the greater utilisation of NMV in decision making about threatened species and ecological communities.

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Appendix 1. The reviewed non-market valuation studies

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
1	Adamowicz, V., Boxall, P., Williams, M. & Louviere, J. (1997). Stated preference approaches for measuring passive use values: An application to woodland caribou conservation in Alberta, Canada. *American Journal of Agricultural Economics*, **79**, 1722-1722.	Canada	CE [a] +CV [b] (DC)	Mail	Woodland Caribou	Least Concern (IUCN); Threatened (SARA, Canada)	Mammal	Not given per houseful. Aggregate value per caribou across all households was $15 (using CE) to $142 (using CV)
2	Bandara, R. & Tisdell, C. (2004). The net benefit of saving the Asian elephant: a policy and contingent valuation study. *Ecological Economics*, **48**, 93-107.	Sri Lanka	CV (DC)	Face to face	Asian Elephant	Endangered	Mammal	$17.10 - $20.65/household/year
3	Becker, N., Inbar, M., Bahat, O., Choresh, Y., G., B.-N. & Yaffe, O. (2005). Estimating the economic value of viewing griffon vultures *Gyps fulvus*: a Travel Cost Model study at Gamla Nature Reserve, Israel. *Oryx*, **39**, 429-434.	Israel	TCM [c]	Face to face	Griffon vulture	Least Concern	Bird	$1.45 - $1.59 million annual benefit
4	Becker, N., Choresh, Y., Bahat, O. & Inbar, M. (2009). Economic analysis of feeding stations as a means to preserve an endangered species: The case of Griffon Vulture (*Gyps fulvus*) in Israel. *Journal for Nature Conservation*, **17**, 199-211.	Israel	TCM+CV (DC)	Face to face	Griffon vulture	Least Concern	Bird	$23.90 - $38/person/year. Annual recreational benefit = $3.1 - $3.8 million
5	Bell, K. P., Huppert, D. & Johnson, R. L. (2003). Willingness to Pay for Local Coho Salmon Enhancement in Coastal Communities. *Marine Resource Economics*, **18**, 15-31.	USA	CV (DC)[d]	Mail	Coho salmon	Not assessed	Fish	$28.85 - $168.25/household/year depending on location and scenario
6	Berrens, R. P., Ganderton, P. & Silva, C. L. (1996). Valuing the protection of minimum instream flows in New Mexico. *Journal of Agricultural and Resource Economics*, **21**, 294-308.	USA	CV (DC)	Mail	Silvery minnow	Endangered	Fish	$44.85/household/year

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
7	Bond, C. A., Giraud Cullen, K. & Larson, D. M. (2009). Joint estimation of discount rates and willingness to pay for public goods. *Ecological Economics*, **68**, 2751-2759.	USA	CV (DC)	Mail	Stellar Sea Lion	Near Threatened	Mammal	Not given
8	Bosetti, V. & Pearce, D. (2003) . A study of environmental conflict: the economic value of Grey Seals in southwest England. *Biodiversity and Conservation,* **12**, 2361-2392.	UK	CV (MBDC)[e]	Mail	Grey seals	Least Concern	Mammal	$16.40/person (for seal sanctuary), $18.85/person (seal watching); $1.02 million non-use value
9	Bostedt, G., Ericsson, G. & Kindberg, J. (2008). Contingent values as implicit contracts: estimating minimum legal willingness to pay for conservation of large carnivores in Sweden. *Environmental & Resource Economics*, **39**, 189-198.	Sweden	CV (MBDC)	Mail	Bears, lynx, wolves and wolverines	Least Concern (all)	Mammal	$9.75-20.90/household/year for 10 years
10	Bowker, J. M. & Stoll, J. R. (1988). Use of dichotomous choice nonmarket methods to value the whooping crane resource. *American Journal of Agricultural Economics*, **70**, 372-381.	USA	CV (DC)	Mail and face to face	Whooping crane	Endangered	Bird	$51.55/person/year
11	Boxall, P. C., Adamowicz, W. L., Olar, M., West, G. E. & Cantin, G. (2012). Analysis of the economic benefits associated with the recovery of threatened marine mammal species in the Canadian St. Lawrence Estuary. *Marine Policy*, **36**, 189-197.	Canada	CE	Online	Beluga whale, blue whale and harbor seal	Near Threatened (Beluga Whale), Endangered (Blue whale), Least Concern (Harbor seal)	Mammal	$74.70 - $222.05/household/year
12	Boyle, K. J. & Bishop, R. C. (1987). Valuing wildlife in benefit-cost analyses - a case-study involving endangered species. *Water Resources Research,* **23**, 943-950.	USA	CV (DC)	Mail	Bald eagle and striped shiner	Least Concern (Both species)	Bird and fish	$25/household/year (Bald eagle); $9.80/household/year (Striped shiner)

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
13	Bulte, E., Gerking, S., List, J. A. & De Zeeuw, A. (2005). The effect of varying the causes of environmental problems on stated WTP values: evidence from a field study. *Journal of Environmental Economics and Management*, **49**, 330-342.	Netherlands	CV (DC)	Television	Seals	Least Concern	Mammal	Not given
14	Cardoso De Mendonça, M. J., Sachsida, A. & Loureiro, P. R. A. (2003). A study on the valuing of biodiversity: the case of three endangered species in Brazil. *Ecological Economics*, **46**, 9-18.	Brazil	Benefit Transfer	_	Black lion tamarin, golden lion tamarin and woolly mouse opossum	Endangered (Black and golden lion tamarin),Least concern (Woolly mouse opossum)	Mammal	$4.35 - $149.90/household/year (Black Lion Tamarin), $1.75 - $58.80/household/year (Golden Lion Tamarin), $8.65 - $291/household/year (Woolly mouse opossum) depending on bounds from prior WTP estimates and elasticity.
15	Chambers, C. M. & Whitehead, J. C. (2003). A contingent valuation estimate of the benefits of wolves in Minnesota. *Environmental & Resource Economics*, **26**, 249-267.	USA	CV (DC)	Mail	Wolf	Least Concern	Mammal	Varies between $5.95 and $28.85/household (lump sum) depending on scenario and location
16	Cummings, R. G., Ganderton, P. T. & Mcguckin, T. (1994). Substitution effects in CVM values. *American Journal of Agricultural Economics*, **76**, 205-214.	USA	CV (OE) †	Mail	Colorado Squawfish	Vulnerable	Fish	13.75/household/year
17	Diffendorfer, J. E., Loomis, J. B., Ries, L., Oberhauser, K., Lopez-Hoffman, L., Semmens, D., Semmens, B., Butterfield, B., Bagstad, K., Goldstein, J., Wiederholt, R., Mattsson, B. & Thogmartin, W. E. (2014). National Valuation of Monarch Butterflies indicates an untapped potential for incentive-based conservation. *Conservation Letters*, **7**, 253-262.	USA	CV (DC)	Online	Monarch butterfly	Not assessed	Insect	$32.10 - $42.45/household (lump sum). Aggregate = 3.49 - 5.41 billion.

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
18	Ekstrand, E. R. & Loomis, J. (1998). Incorporating respondent uncertainty when estimating willingness to pay for protecting critical habitat for threatened and endangered fish. *Water Resources Research*, **34**, 3149-3155.	USA	CV (DC)	Mail	9 endangered fish species	Endangered (ESA, USA)	Fish	$74.10 to $489/household/year depending on model
19	Ericsson, G., Kindberg, J. & Bostedt, G. (2007). Willingness to pay (WTP) for wolverine *Gulo gulo* conservation. *Wildlife Biology*, **13**, 2-13.	Sweden	CV (MBDC)	Mail	Wolverine	Least Concern	Mammal	$50.45 to $88.85/person/year depending on location
20	Ericsson, G., Bostedt, G. & Kindberg, J. (2008). Wolves as a symbol of people's willingness to pay for large carnivore conservation. *Society & Natural Resources*, **21**, 294-309.	Sweden	CV (MBDC)	Mail	Bears, lynx, wolves and wolverines	Least Concern	Mammal	$72.60 - $118.65/person/year (large carnivores) and $71 - $114.50/person/year (wolves)
21	Garcia-De La Fuente, L., Colina, A., Colubi, A. & Gonzalez-Rodriguez, G. (2010). Valuation of Environmental Resources: The case of the brown bear in the north of Spain. *Environmental Modeling & Assessment*, **15**, 81-91.	Spain	CV (DC)	Face to face	Brown bear	Least Concern	Mammal	$68.70 to $85.55/person depending on model
22	Giraud, K. L., Loomis, J. B. & Johnson, R. L. (1999). Internal and external scope in willingness-to-pay estimates for threatened and endangered wildlife. *Journal of Environmental Management*, **56**, 221-229.	USA	CV (DC)	Mail	Mexican spotted owl and 61 other Threatened & Endangered (T&E) species	Near Threatened (Mexican Spotted Owl)	All	Varies between $72.80 and $96.70/year for the Mexican spotted owl and between $90.20 and $178.65 for all 62 T&E species.
23	Giraud, K. L., Loomis, J. B. & Cooper, J. C. (2001). A comparison of willingness to pay estimation techniques from referendum questions - Application to endangered fish. *Environmental & Resource Economics*, **20**, 331-346.	USA	CV (DC)	Mail	Fish species		Fish	Varies between $230.05 and $$282.35/household/year depending on model. National WTP between $21.07 and $25.92 billion.
24	Giraud, K., Turcin, B., Loomis, J. & Cooper, J. (2002). Economic benefit of the protection program for the Steller sea lion. *Marine Policy*, **26**, 451-458.	USA	CV (DC)	Mail	Stellar Sea Lion	Near Threatened	Mammal	$84.25/household/year. Aggregated = $8.01 million annually.

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
25	Hageman, R. K. (1985). *Valuing marine mammal populations: benefit valuations in a multi-species ecosystem.* La Jolla, California, USA: Southwest Fisheries Center.	USA	CV (PC) [9]	Mail and face to face	Bottlenose dolphin, northern elephant seal, Grey and blue whales and sea otter	Least Concern (Bottlenose dolphin, northern elephant seal, Gray Whale); Endangered (Blue whale and sea otter)	Mammal	$42.95/year (Bottlenose dolphin), $40.70/year (Northern elephant seal), $54.20/year (Gray Whale), 46.95/year (sea otter)
26	Hagen, D. A., Vincent, J. W. & Welle, P. G. (1992). Benefits of preserving old-growth forests and the Spotted Owl. *Contemporary Policy Issues*, **10**, 13-26.	USA	CV (DC)	Mail	Northern Spotted owl	Not listed (IUCN); Threatened (ESA, USA)	Bird	$142.70/year
27	Han, S.-Y. & Lee, C.-K. (2008). Estimating the value of preserving the Manchurian black bear using the contingent valuation method. *Scandinavian Journal of Forest Research*, **23**, 458-465.	South Korea	CV (DC)	Face to face	Manchurian black bear	Vulnerable	Mammal	$6.10/household (lump sum). Aggregated = $4.46 million.
28	Han, S.-Y., Lee, C.-K., Mjelde, J. W. & Kim, T.-K. (2010). Choice-experiment valuation of management alternatives for reintroduction of the endangered mountain goral in Woraksan National Park, South Korea. *Scandinavian Journal of Forest Research*, **25**, 534-543.	South Korea	CE	Face to face	Mountain goral	Vulnerable	Mammal	$14.45-$39.80/household (lump sum) depending on scenario.
29	Hanley, N., Macmillan, D., Patterson, I. & Wright, R. E. (2003). Economics and the design of nature conservation policy: a case study of wild goose conservation in Scotland using choice experiments. *Animal Conservation*, **6**, 123-129.	UK	CE	Face to face	Wild goose	Least Concern	Bird	$14.10 - $62.10/household/year depending on policy scenario
30	Hynes, S. & Hanley, N. (2009). The "Crex crex" lament: Estimating landowners willingness to pay for corncrake conservation on Irish farmland. *Biological Conservation*, **142**, 180-188.	Ireland	CV (PC)	Face to face	Corncrake	Least Concern	Bird	$17.50/farm/year.

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
31	Jakobsson, K. M. & Dragun, A. K. (2001). The worth of a possum: Valuing species with the contingent valuation method. *Environmental & Resource Economics*, **19**, 211-227.	Australia	CV (DC and PC)	Mail	Leadbeater's possum	Endangered	Mammal	Varies between AU$29.18 - AU$75.55/household/year (Tax) and between AU$0 - AU$36.45/household/year (Donation) depending on model and if protest bids were included or not.
32	Jin, J., Wang, Z. & Liu, X. (2008). Valuing Black-faced Spoonbill conservation in Macao: A policy and contingent valuation study. *Ecological Economics*, **68**, 328-335.	China	CV (DC)	Drop-off and pick-up	Black-faced spoonbill	Endangered	Bird	$2.60 - $5.55/household/month for five years. Aggregate = $18.35 - $39 million for 5 years.
33	Kim, J.-Y., Mjelde, J. W., Kim, T.-K., Lee, C.-K. & Ahn, K.-M. (2012). Comparing willingness-to-pay between residents and non-residents when correcting hypothetical bias: Case of endangered Spotted Seal in South Korea. *Ecological Economics*, **78**, 123-131.	South Korea	CV (DC)	Face to face	Spotted seal	Data deficient	Mammal	$5.30/household - $25.05/household (lump sum)
34	Kontogianni, A., Tourkolias, C., Machleras, A. & Skourtos, M. (2012). Service providing units, existence values and the valuation of endangered species: A methodological test. *Ecological Economics*, **79**, 97-104.	Greece	CV (OE)	Face to face	Mediterranean monk seal	Critically Endangered	Mammal	$72.25/household/year
35	Kontoleon, A. & Swanson, T. (2003). The willingness to pay for property rights for the Giant Panda: Can a charismatic species be an instrument for nature conservation? *Land Economics*, **79**, 483-499.	UK	CV	Face to face	Giant Panda	Endangered	Mammal	$5.70 (Cage Scenario), $12.30 (Pen Scenario), $21.70 (Reserve Scenario) (/person) (lump sum)
36	Kotchen, M. J. & Reiling, S. D. (2000). Environmental attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species. *Ecological Economics*, **32**, 93-107.	USA	CV (DC)	Mail	Peregrine falcon and Shortnose sturgeon	Least Concern (Pergine Falcon); Vulnerable (Shortnose sturgeon)	Bird and Fish	$37.65 (falcon)and $38.85 (sturgeon) (lump sum)

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
37	Langford, I. H., Kontogianni, A., Skourtos, M. S., Georgiou, S. & Bateman, I. J. (1998). Multivariate mixed models for open-ended contingent valuation data - Willingness to pay for conservation of monk seals. *Environmental & Resource Economics*, **12**, 443-456.	Greece	CV (OE)	Face to face	Mediterranean monk seal	Critically Endangered	Mammal	$29.10/household/year
38	Lew, D. K., Layton, D. F. & Rowe, R. D. (2010). Valuing Enhancements to Endangered Species Protection under Alternative Baseline Futures: The Case of the Steller Sea Lion. *Marine Resource Economics*, **25**, 133-154.	USA	CE	Telephone	Stellar Sea Lion	Near Threatened	Mammal	$41.10-$234.30/household/year depending on policy scenario
39	Lindsey, P. A., Alexander, R. R., Du Toit, J. T. & Mills, M. G. L. (2005). The potential contribution of ecotourism to African wild dog *Lycaon pictus* conservation in South Africa. *Biological Conservation*, **123**, 339-348.	South Africa	CV (OE)	Face to face	African wild dog	Endangered	Mammal	$15.85 - $78/person/trip depending on National Park
40	Loomis, J., Larson, D.M (1994). Total economic values of increasing gray whale populations: results from a contingent valuation survey of visitors and households. *Marine Resource Economics*, **9**, 275-286.	USA	CV (OE)	Mail and face to face	Gray whale	Least Concern	Mammal	$28.25 - $51.90/household/year depending on policy scenario
41	Loomis, J. (1996). Measuring the economic benefits of removing dams and restoring the Elwha River: Results of a contingent valuation survey. *Water Resources Research*, **32**, 441-447.	USA	CV (DC)	Mail	Salmon and steelhead	Varies between data deficient and critically endangered depending on species (Salmon); Vulnerable (Steelhead)	Fish	$94.70/household/year (Challam County, WA, USA), $117.15/household/year (Washington state) and $109.15/household/year (Rest of U.S).

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
42	Loomis, J. & Ekstrand, E. (1997). Economic benefits of critical habitat for the Mexican spotted owl: A scope test using a multiple-bounded contingent valuation survey. *Journal of Agricultural and Resource Economics*, **22**, 356-366.	USA	CV (MBDC)	Mail	Mexican spotted owl and 61 other Threatened & Endangered (T&E) species	Near Threatened (Mexican Spotted Owl)	All	$60.65/household/year (Mexican Spotted Owl) and $74.30/household/year (62 T&E Species)
43	Loomis, J. (2006). Estimating recreation and existence values of sea otter expansion in California using benefit transfer. *Coastal Management*, **34**(4), 387-404. doi:10.1080/08920750600860282	USA	Benefit Transfer	_	Sea Otter	Endangered	Mammal	$24.77 million non-use values and $1.77 - $9.67 million direct income from sea otter tourism.
44	Macmillan, D. C., Philip, L., Hanley, N. & Alvarez-Farizo, B. (2002). Valuing the non-market benefits of wild goose conservation: a comparison of interview and group-based approaches. *Ecological Economics*, **43**, 49-59.	UK	CV (PC)	Face to face	Wild goose	Least Concern	Bird	$7.70 - $32/household/year depending on interview technique
45	Macmillan, D., Hanley, N. & Daw, M. (2004). Costs and benefits of wild goose conservation in Scotland. *Biological Conservation*, **119**, 475-485.	UK	CV (PC)	Face to face	Wild goose	Least Concern	Bird	$16.75 - $33.50/household/year depending on policy scenario. Aggregate WTP = $24.17- $63.53 million annually
46	Macmillan, D. C. & Leader-Williams, N. (2008). When successful conservation breeds conflict: an economic perspective on wild goose management. *Bird Conservation International*, **18**, S200-S210.	UK	CE	Face to face	Wild goose	Least Concern	Bird	$0- $9.60/household/year (General public), $0 - $52.25/household/year (Residents in the region), $0 - $34.55/household/year (Visitors) depending on attribute and level.
47	Mitani, Y., Shoji, Y. & Kuriyama, K. (2008). Estimating economic values of vegetation restoration with choice experiments: a case study of an endangered species in Lake Kasumigaura, Japan. *Landscape and Ecological Engineering*, **4**, 103-113.	Japan	CE	Online	Fringed water lily	Least Concern	Plant	$11.65 - $74.60

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
48	Montgomery, C. A. & Helvoigt, T. L. (2006). Changes in attitudes about importance of and willingness to pay for salmon recovery in Oregon. *Journal of Environmental Management*, **78**, 330-340.	USA	CV (PC)	Telephone	Salmon	Varies between data deficient and critically endangered depending on species	Fish	Not given
49	Navrud, S. & Mungatana, E. D. (1994). Environmental valuation in developing countries: The recreational value of wildlife viewing. *Ecological Economics*, **11**, 135-151.	Kenya	CV (PC) and TCM	Face to face	Lesser flamingo	Near Threatened	Bird	$33.95/visitor (Increased expenditure) and $38.20/visitor (Flamingo Fund). Value of flamingo viewing = $8.73 - 9.60 million
50	Ninan, K. N. & Sathyapalan, J. (2005). The economics of biodiversity conservation: a study of a coffee growing region in the Western Ghats of India. *Ecological Economics*, **55**, 61-72.	India	CV (OE)	Face to face	Asian Elephant	Endangered	Mammal	$70.80/household/year (Maldari region) and $165.15/household/year (Uttara Kannada region)[h]
51	Ojea, E. & Loureiro, M. L. (2007). Altruistic, egoistic and biospheric values in willingness to pay (WTP) for wildlife. *Ecological Economics*, **63**, 807-814.	Spain	CV (DC)	Face to face	Common murre	Least Concern	Bird	
52	Ojea, E. & Loureiro, M. L. (2009). Valuation of wildlife: Revising some additional considerations for scope tests. *Contemporary Economic Policy*, **27**, 236-250.	Spain	CV (DC)	Face to face	Common murre	Least Concern	Bird	
53	Ojea, E. & Loureiro, M. L. (2010). Valuing the recovery of overexploited fish stocks in the context of existence and option values. *Marine Policy*, **34**, 514-521.	Spain	CV (DC)	Face to face	Hake and Norwegian lobster	Least concern to data deficient (hake); Least concern (Norwegian lobster)	Fish and crustacean	$23.45/household/year (Norwegian lobster), $36.40/household/year (Hake)
54	Reaves, D. W., Kramer, R. A. & Holmes, T. P. (1999). Does question format matter? Valuing an endangered species. *Environmental & Resource Economics*, **14**, 365-383.	USA	CV (DC, PC, OE)	Mail	Red cockaded woodpecker	Near Threatened	Bird	$12.80/person/year (Payment card), $14.25/person/year (Open ended) $17.40/person/year (Dichotomous choice)

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
55	Rubin, J., Helfand, G. & Loomis, J. (1991). A benefit-cost analysis of the Northern Spotted Owl - Results from a Contingent Valuation survey. *Journal of Forestry*, **89**, 25-30.	USA	CV (PC)	Mail	Northern Spotted owl	Not assessed (IUCN); Threatened (ESA, USA)	Bird	$46.05/household/year (50% chance of survival) and $47.70/household/year (75% chance of survival)
56	Samples, K. C., Dixon J.A. & Gowen M.M. (1986). Information disclosure and endangered species valuation. *Land Economics*, **62**, 306-312.	USA	CV (OE)	Mail	Humpback whale	Least Concern	Mammal	$123.80/person/year (Experimental Group) and $94.85/person/year (Control Group)
57	Solomon, B. D., Corey-Luse, C. M. & Halvorsen, K. E. (2004). The Florida manatee and eco-tourism: toward a safe minimum standard. *Ecological Economics*, **50**, 101-115.	USA	CV (PC)	Mail	Florida manatee	Vulnerable	Mammal	$28.80/household/year. Aggregated over the study region = $260,830 annually.
58	Stanley, D. L. (2005). Local perception of public goods: Recent assessments of willingness-to-pay for endangered species. *Contemporary Economic Policy*, **23**, 165-179.	USA	CV (OE PC)	Mail	Riverside fairy shrimp	Endangered	Crustacean	$28.45/household/year (Riverside fairy shrimp), Aggregated over the entire survey region = $10.07 - $10.74 annually.
59	Stevens, T. H., Echeverria, J., Glass, R. J., Hager, T. & More, T. A. (1991). Measuring the existence value of wildlife - what do CVM estimates really show. *Land Economics,* **67**, 390-400.	USA	CV (DC and OE)	Mail	Salmon, bald eagle, coyote, wild turkey	Least concern (all)	Bird, Fish and Mammal	Bald eagle: $37/person/year. Wild turkey: $22.75/person/year. Coyote control: $8.05/person/year. Coyote preservation: $10.25/person/year. Salmon: $15.20/person/year.
60	Stithou, M. & Scarpa, R. (2012). Collective versus voluntary payment in contingent valuation for the conservation of marine biodiversity: An exploratory study from Zakynthos, Greece. *Ocean & Coastal Management*, **56**, 1-9.	Greece	CV (OE)	Drop-off	Loggerhead turtle and Mediterranean monk seal	Endangered (Loggerhead Turtle); Critically Endangered (Mediterranean monk seal)	Reptile and Mammal	Varies between $17.60 - $32.95 (Loggerhead Turtle) and $18.15 - $30.60 (Mediterranean monk seal) depending on payment method and questionnaire design.

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
61	Swanson, C. S., Mccollum, D. W. & Maj, M. (1994). Insights into the economic value of grizzly bears in the Yellowstone Recovery Zone. In: Claar, J. J. & Schullery, P. (eds.) *International Conference on Bear Research and Management*.	USA	Consolidation of studies	_	Grizzly bear	Least Concern	Mammal	
62	Tanguay, M., Wiktor, L. & Boxall, P. (1992). *An economic evaluation of woodland caribou conservation programs in Northwestern Saskatchewan.* Project Report 95-01. Department of Rural Economy, University of Alberta, Canada.	Canada	CV (DC and OE)	Mail	Woodland Caribou	Least Concern (IUCN); Threatened (SARA, Canada)	Mammal	$18.10 /person/year (open ended format), $39.90/person/year (Dichotomous choice format).
63	Tisdell, C., Wilson, C. & Swarna Nantha, H. (2005). Policies for saving a rare Australian glider: economics and ecology. *Biological Conservation*, **123**, 237-248.	Australia	CV (OE)	Face to face	Mahogany glider	Endangered	Mammal	AU$6.00 - $31.20/person depending on respondent's knowledge level and the survey version
64	Tisdell, C. & Wilson, C. (2006). Information, wildlife valuation, conservation: Experiments and policy. *Contemporary Economic Policy*, **24**, 144-159.	Australia	CV (OE)	Face to face	24 Australian species		Mammal, birds and reptiles	Not given
65	Tisdell, C. & Nantha, H. S. (2007). Comparison of funding and demand for the conservation of the charismatic koala with those for the critically endangered wombat *Lasiorhinus krefftii*. *Biodiversity and Conservation*, **16**, 1261-1281.	Australia	CV (OE)	Face to face	Koala and Northern Hairy-nosed wombat	Least Concern (Koala); Critically Endangered (Northern Hairy-nosed Wombat)	Mammal	AU$1.73 to AU$1.94/person/week (for Northern hairy-nosed wombat) and AU$1.40 to AU$1.45/person/week (for Koala).
66	Tisdell, C., Nantha, H. S. & Wilson, C. (2007). Endangerment and likeability of wildlife species: How important are they for payments proposed for conservation? *Ecological Economics*, **60**, 627-633.	Australia	CV (OE)	Face to face	24 Australian species		Mammal, birds and reptiles	Not given

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
67	Verissimo, D., Fraser, I., Groombridge, J., Bristol, R. & Macmillan, D. C. (2009). Birds as tourism flagship species: a case study of tropical islands. *Animal Conservation*, **12**, 549-558.	UK	CE	Face to face	20 native bird species	Varies	Bird	Not given
68	Wallmo, K. & Lew, D. K. (2011). Valuing improvements to threatened and endangered marine species: an application of stated preference choice experiments. *Journal of Environmental Management*, **92**, 1793-801.	USA	CE	Online	Chinook salmon, Hawaiian monk seal & small tooth sawfish	Not Assessed (Chinook Salmon); Endangered (Hawaiian Monk Seal); Critically Endangered (Small tooth Sawfish)	Mammal and fish	Smalltooth sawfish ($58.55), Puget Sound Chinook salmon ($51.85), Hawaiian monk seal ($75.25) (/household/year)
69	Wallmo, K. & Lew, D. K. (2012). Public willingness to pay for recovering and downlisting threatened and endangered marine species. *Conservation Biology*, **26**, 830-8	USA	CE	Online	Upper Willamette River Chinook salmon, Puget Sound Chinook salmon, Loggerhead sea turtle, Leatherback sea turtle, North Atlantic right whale, North Pacific right whale, Hawaiian monk seal and small tooth sawfish.	Not Assessed (Chinook Salmon); Vulnerable (Leatherback sea turtle); Endangered (Loggerhead sea turtle, North Atlantic and North Pacific right whales, Hawaiian monk seal); Critically Endangered (Small tooth Sawfish)	Mammal, fish and reptile	North Pacific right whale ($80.95); North Atlantic right whale ($79.80); Leatherback sea turtle ($75.40); Hawaiian monk seal ($73.15); Smalltooth sawfish ($57.65); Loggerhead sea turtle ($48.80); Upper Willammette River Chinook salmon ($45.45); Puget Sound Chinook salmon ($44.35) (/household/year)
70	White, P. C. L., Gregory, K. W., Lindley, P. J. & Richards, G. (1997). Economic values of threatened mammals in Britain: A case study of the otter *Lutra lutra* and the water vole *Arvicola terrestris*. *Biological Conservation*, **82**, 345-354.	UK	CV (DC)	Telephone	Eurasian Otter and water vole	Near Threatened (Eurasian Otter); Least Concern (Water vole)	Mammal	$27.35/person (Otter) and $17.10/person (Water vole) (lump sum)

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
71	White, P. C. L., Bennett, A. C. & Hayes, E. J. V. (2001). The use of willingness-to-pay approaches in mammal conservation. *Mammal Review*, **31**, 151-167.	UK	CV (DC)	Telephone	Eurasian red squirrel, European hare, Eurasian otter and water vole	Near Threatened (Eurasian Otter); Least Concern (Eurasian red squirrel, European hare, Water vole)	Mammal	$6.50/person (Red squirrel) and $0/person (Brown hare) (lump sum)
72	Whitehead, J. C. (1992). Ex ante willingness to pay with supply-and-demand uncertainty - implications for valuing a sea-turtle protection program. *Applied Economics*, **24**, 981-988.	USA	CV (DC)	Mail	Loggerhead sea turtle	Endangered	Reptile	$58/year
73	Wilson, C., Tisdell, C. (2007). How knowledge affects payment to conserve an endangered bird. *Contemporary Economic Policy*, **25**, 226–237.	Australia	CV (OE)	Face to face	Golden shouldered parrot, Tree kangaroo, Hawksbill sea turtle	Endangered (Golden shouldered parrot); Vulnerable (Tree Kangaroo); Critically Endangered (Hawksbill Turtle)	Bird, Mammal and Reptile	Before (after) information provided: AU$72.8 (AU$75.40), AU$98.96 (AU$74.36), and AU$81.64 (AU$70.72) per year for Golden shouldered parrot, Tree Kangaroo and Hawksbill Turtle, respectively.
74	Yao, R. T., Scarpa, R., Turner, J. A., Barnard, T. D., Rose, J. M., Palma, J. H. N. & Harrison, D. R. (2014). Valuing biodiversity enhancement in New Zealand's planted forests: Socioeconomic and spatial determinants of willingness-to-pay. *Ecological Economics*, **98**, 90-101.	New Zealand	CE	Mail and online	Brown Kiwi, Kokopu, Kakabeak, Green gecko, Bush Falcon,	Endangered (Brown Kiwi), Vulnerable (Kokopu), Endangered (Kakabeak), Gradual Decline (Green gecko, NZ TCS), Near Threatened (Bush Falcon)	Bird, Fish, Reptile and Plant	Brown Kiwi($20.45/year), Kokopu ($6.30/year), Kakabeak ($6.70/year), Bush Falcon ($22.05/year)

	Paper/Reference	Country	Valuation Method	Elicitation Method	Species	Conservation Status (IUCN)	Species class	Mean annual WTP (2015 US$) unless otherwise specified
75	Zander, K. K., Ainsworth, G. B., Meyerhoff, J. & Garnett, S. T. (2014). Threatened bird valuation in Australia. *PLOS One*, **9**, 1-9.	Australia	CV (DC)	Online	Birds	Threatened (EPBC, Australia)	Bird	AU$11.25/person/year
76	Zander, K. K., Pang, S. T., Jinam, C., Tuen, A. A. & Garnett, S. T. (2014). Wild and Valuing tourist values for Orang-utan conservation in Sarawak. *Conservation & Society*, **12**, 27-42.	Malaysia	CE	Face to face	Orangutan	Endangered	Mammal	$37 - $181.85/person depending on scenario.

[a] CE – Choice Experiment; [b] CV– Contingent Valuation; [c] TCM – Travel Cost Method; [d] DC – Dichotomous Choice (single bounded) CV format; [e] MBDC – Multiple Bounded Dichotomous Choice CV format; [f] OE – Open Ended CV format; [g] PC – Payment Card CV format; [h] Elicited as days of participation in an elephant conservation program and converted to a monetary value using opportunity cost of income forgone.

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