Master Thesis

The benefits of wildlife: a meta-analysis

IVM Institute for Environmental Studies – Vrije Universiteit Amsterdam

Name	Elisa van Zanten
Student number	2599719
Supervisor	Pieter van Beukering
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Abstract

Governments need to invest in conservation projects to reduce biodiversity loss. Economic valuation can be used to understand the trade-offs involved in prioritizing investments in projects aiming to preserve wildlife. However, valuation studies are expensive, time-consuming, and impractical to carry out for each wildlife species. Nevertheless, numerous valuation studies of wildlife have been conducted in the last years. In this study, a database is composed existing of 110 of such valuation studies providing 474 willingness to pay values for wildlife. The willingness to pay values range from \$0.04 to \$1829.43. A meta-analysis of the valuation data was performed to gain insight into the factors influencing the benefits of wildlife. A simple multiple linear regression was run to determine what variables influence the willingness to pay. Both characteristics of the wildlife valuation studies conducted to determine the willingness to pay and characteristics describing the species that were valued were found to significantly affect the willingness to pay for wildlife. The findings on the study characteristics expose what to consider when designing a study and interpreting its results. The animal characteristics that were found to influence the value of a species can be considered in comparing the benefits of different species.

Foreword

This project is my graduation work for the master Environment and Resource Management at the VU University. The project was conducted at the Institute for Environmental Studies. This study aimed to determine the factors that influence the positive social impacts of wildlife. The study is an updated version of McLennan et al. (2009) that conducted a meta-analysis of existing wildlife valuation literature. Since 2009, new wildlife valuation studies have been published. The project was split up due to the large body of existing wildlife valuation literature. Elise Elmendorp, a colleague ERM student, took care of the wildlife valuation literature of the negative social impacts of wildlife.

This project helped me to become experienced in conducting a meta-analysis and the associated statistical analysis. It also helped me to improve my knowledge on the subject of the economic valuation of ecosystem services.

First of all, special thanks to the project supervisor prof. dr. Pieter van Beukering, environmental economist, and professor and director at the Institute for Environmental studies. He helped to define the purpose of the study and provided relevant feedback throughout the project. Pieter arranged to get in touch with dr. Luke Brander, an environmental economist and an expert in meta-analyses.

Many thanks to Luke Brander and his associate Victoria Guisado Goñi for their data, their help with the aesthetical attractiveness survey, and their advice for conducting a regression analysis.

Grateful for current student Elise Elmendorp (VU University-ERM) that provided advice, relevant insights, and data. We worked in close collaboration on a joint research project to address the tension between species conservation and harmful patterns of human-wildlife conflicts.

Lastly, I would like to thank the former student Staci McLennan for the data and report of her research project conducted in 2009. This ultimately formed the basis of this research on which I could build further.

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1 Introduction

Goal 15 of the Sustainable Development Goals (SDGs) of the United Nations 2030 agenda is devoted to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss" (United Nations, 2015). Goal 15 is highly needed, as 28% of all assessed species are threatened with extinction (IUCN, 2020). According to IUCN's 2020 Red List, one in three amphibians, one in four mammals, one in three conifers, one in eight birds, one in three sharks & rays, one in three reef corals, and one in four of the selected crustaceans are now endangered (IUCN, 2020). The growing evidence of ongoing climate change has raised further concerns regarding species' distribution in the future. Climate change may disrupt the geographical distribution of species and their life zones. These increased concerns about biodiversity loss pressurize conservation management to come up with cost-efficient strategies. Governmental investments in conservation projects are necessary to prevent the extinction of many wildlife species. Policymakers have to decide what conservation projects to invest in. Besides cost-effectiveness, widespread support is an essential factor in the success of public investments in conservation efforts (Lundhede et al., 2014).

Economic valuation can be used to understand the trade-offs involved in prioritizing public investments in projects to preserve wildlife. Valuating the costs and benefits of conservation efforts is challenging. Market prices capturing wildlife species' values rarely exist, making it difficult to assign value to wildlife (Gren et al., 2018). When market prices do exist, they mostly fail to reflect all types of use and non-use values (Bowker & Stoll, 1988). To account for society as a whole, all types of values must be considered in determining the total economic value of wildlife. Fortunately, more and more research into wildlife valuation is being conducted. Such valuation studies use market and non-market valuation techniques to quantify wildlife's benefits and costs (Subroy et al., 2019). The stated preference method is an often used non-market valuation technique to determine the Willingness-To-Pay (WTP) (Loomis & White, 1996). Depending on the survey design, reported WTP estimates could reflect the total economic value of wildlife as well as just one of the value types. According to Subroy et al. (2019), valuation studies can be expensive, time-consuming, and impractical to carry out for each wildlife species. Therefore, the study suggests the benefits transfer technique of extrapolating WTP values from previous studies by conducting a meta-analysis as a practical and cost-saving alternative.

This study presents a research conducted at the Institute of Environmental Studies (IVM) for a final thesis of the Master program entitled "Environment and Resource Management". In order to identify the characteristics of the valuation of wildlife species, a global meta-analysis of valuation studies that measure the social and intrinsic value of wildlife was conducted. The study is part of a project which seeks to provide insight into the tension between the benefits of species conservation and the harm caused by such wildlife species. To that end, the project seeks to weigh the results of this study against a global meta-analysis of valuation studies on the costs of the human-wildlife conflict (HWC). As part of this, a basic cost-benefit assessment was conducted on a few species that were reported to have both positive and negative social impacts (Elmendorp, 2021).

The first objective of this study is to compose an all-embracing database of existing wildlife valuation literature. All studies that present a WTP value valuing one or more wildlife species are included within the database. The second goal is to find the factors that significantly influence the social and intrinsic values of wildlife. This gains insight into the descriptive characteristics of the WTP for wildlife species. The third objective is to assess the costs and benefits of wildlife and provide insights into how these can be better linked.

In order to address these objectives, the research aimed to answer the following research question:

"What are the main factors influencing the benefits of wildlife around the world?"

From the research question, the following sub-questions were derived and addressed in this study:

- What are the characteristics of the current literature on the valuation of wildlife?
- How do geographical characteristics affect the benefits of wildlife?
- How does the endangerment status of a species affect its benefits?
- How do the characteristics of how a valuation study is conducted affect the benefits of wildlife?
- How do the characteristics of a species affect its benefits?

The value per animal was determined for species that were studied to have both positive and negative social impacts. The value per animal was addressed to make the valuation of benefits more intelligible.

- How do the benefits per animal compare to the costs per animal?

The study is structured in 6 chapters as follows. Chapter 1 presents the introduction, the research question and sub-questions, and the purpose of the study. Chapter 2 provides background information about the economic valuation of wildlife and existing meta-analysis studies in the area of environmental valuation. Further, chapter 3 provides a detailed description of how the study is conducted. The results are presented in chapter 4, composed of a description of the data, the meta-regression results, and the values per animal of species that were studied to have both positive and negative social impacts. The results are discussed, the findings are compared to existing literature, and the limitations of the study are presented in chapter 5. Finally, the main findings and recommendations for further research are presented in chapter 6.

2 Background

2.1 Economic values of ecosystem services

Ecosystems are natural resources that provide flows of goods and services. The concept of ecosystem services has been developed to describe the value of ecosystems to people. The National Wildlife Federation of the United States (n.d.) defines an ecosystem service as "Any positive benefit that wildlife or ecosystems provide to people. The benefits can be direct or indirect—small or large.". The valuation of ecosystem services aims to enable better-informed and, as a result, more efficient trade-offs between all of society's limited resources. Reasons to use valuation of ecosystem services can be: advocating the economic importance of the environment; assisting decision-makers in making better-informed and more transparent decisions; assessing damage to determine the required compensation; and setting taxes, fees, or charges for the use of ecosystem services (van Beukering et al., 2015).

The taxonomy describing the different types of values associated with the goods and services provided by ecosystems presented in Figure 1 can be used to address the multi-faceted nature of the benefits of ecosystem services. This taxonomy is based on the concept of total economic value (TEV), which is equal to the sum of the components presented in Figure 1. Three types of use values can be distinguished: direct use values that arise from the active use of ecosystems' goods and services; indirect use values that are related to goods and services that do not entail direct use; and option values that arise from goods or services that are potentially useful in the future. Besides use values, ecosystems also provide non-use values. These are values that are not related to the current or future use of a good or service. Non-use values can also be divided into three types of values: the existence value is the value of preserving ecosystem services independent from its current or possible future use; the bequest value is the satisfaction derived from knowing that future generations will be able to use the resource; and altruistic value is the satisfaction derived from knowing that people currently can use the resource (van Beukering et al., 2015).

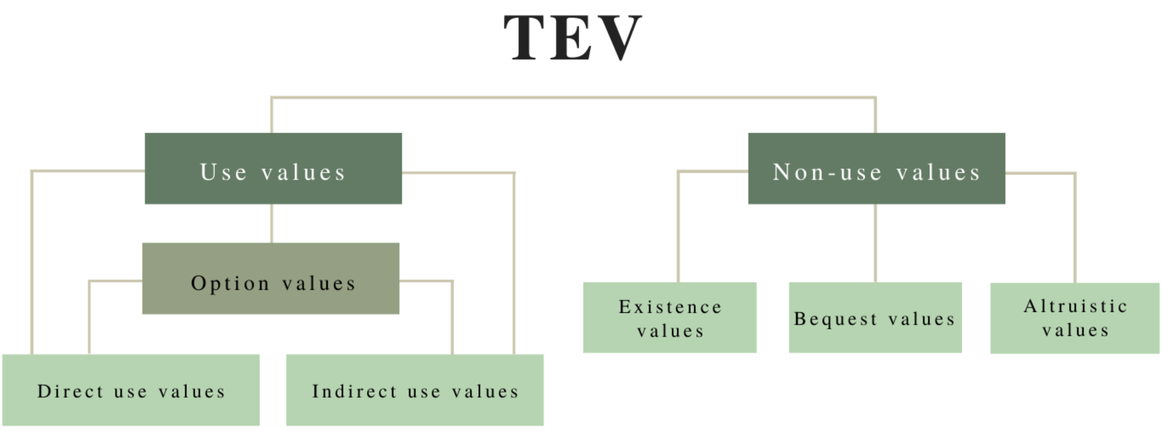

Figure 1 Taxonomy describing the different types of values associated with ecosystem services.

2.2 Economics of wildlife

The economic valuation of ecosystems services has quickly established itself as a practical technique to assist decision-making in biodiversity conservation (Marre et al., 2015). The economic value of wildlife can consist of both positive and negative values (i.e. benefits and costs). Typical examples of negative values of wildlife are the demolition of crops, predation on livestock, and transmission of diseases to animals and humans (Gren et al., 2018). These costs of wildlife are divided into three categories: costs for actual damage, mitigation costs, and costs for adaption measures. Also, wildlife may create indirect costs from reduced weaning weight, decreased conception rate, reduced weight gain, and increased sickness of the kept livestock (Gren et al., 2018). Gren et al. (2018) identified two commonly used methods for calculating the costs of wildlife: questionnaires to stakeholders on actual costs and compensation payments analysis. An increasingly recognized form of damage assessment is the willingness to accept an environmental welfare loss (Elmendorp, 2021). The database of Elmendorp (2021), including 80 damage cost observations, 11 values based on compensation data, and three willingness to accept observations found in 28 publications, implies that much research is being done on wildlife's negative social impacts.

In contrast to the negative social impacts of wildlife, there are multiple reasons why people might value the existence of wildlife positively. The benefits of preserving or expanding ecosystem services related to wildlife can be classified using the taxonomy presented in Figure 1. Use values are related to animals' active use. This category is composed of three types: first, the consumption of an animal itself or its derivatives (direct); second, the pleasure that people get from seeing an animal in the wild environment in which it lives (indirect); third, the pleasure that people get by reading about animals, seeing pictures of animals, or watching videos of animals (indirect) (Marre et al., 2015). The option value expresses the WTP to preserve the option of future use of the before-mentioned use values (Cicia et al., 2003). Non-use values are divided into three categories: the satisfaction of continued existence of a species (existence value); the satisfaction that the species will be available for future generations (bequest value); and the satisfaction that a species is available for others in the current generation (altruistic value) (Tanguay et al., 1995).

In general, the benefits of use values are easy to monetize, as these are often traded in markets. In which case, the market price expresses the benefits of these use values (Gren et al., 2018). Usually, the non-use values of wildlife to society are not expressed in monetary terms. Monetary values simplify comparing the benefits in a standard metric (Shwiff et al., 2013). Marre et al. (2015) argue that measuring the benefits of non-use values using WTP is the correct measure to monetize the total benefits of wildlife. Often, stated preference methods are used to survey the WTP of individuals or households for ecosystem services related to wildlife conservation. Stated preference methods include the contingent valuation method (CV) and discrete choice experiments (CE) (Marre et al., 2015).

2.3 Meta-analysis: Wildlife valuation

Various meta-analysis studies have been published in the area of environmental valuation; for example, Brouwer et al. (1999) conducted one into the use and non-use values of wetlands, Lindhjem (2007) did a meta-analysis of forest valuation studies, and Lara-Pulido et al. (2018) performed a meta-analysis of economic valuation of ecosystem services in Mexico. As summarised in Table 1, only a limited number of meta-analyses of wildlife valuation are known.

Table 1 Summary of existing meta-analyses of wildlife valuation literature

Reference	**Number of studies**	**Number of observations**	**Scope**	**Subject**
Loomis & White (1996)	25	43	The United States	Wildlife
Richardson & Loomis (2009)	31	67	The United States	Wildlife
McLennan et al. (2009)	41	91	Global	Wildlife
Jacobsen & Hanley (2009)	46	145	Global	Biodiversity conservation
Lindhjem & Tuan (2012)	95	550	Asia & Oceania	Biodiversity conservation
Subroy et al. (2019)	47	109	Global	Wildlife

A couple of meta-analyses on WTP for biodiversity conservation also look into wildlife valuation (Jacobsen & Hanley, 2009; Lindhjem & Tuan, 2012). Jacobsen & Hanley (2009) included studies that estimated species and other ecosystem services that influenced wildlife preservation. Lindhjem & Tuan (2012) conducted a meta-analysis of around 100 studies which could be divided into two categories, endangered species and nature conservation more generally. Both studies combine disparate valuations making it challenging to extract values of specific species of wildlife.

A meta-analysis of CV studies of threatened species conducted by Loomis & White (1996) set the standard for meta-analyses of wildlife valuation. This study analyzed 20 CV studies for 18 wildlife species. Over a decade ago, Richardson & Loomis (2009) updated the analysis by adding 11 valuation studies, bringing the total number of valued species to 23. Both studies are limited in terms of geographic focus, as these only analyze United States-based studies. Moreover, the range of species valued is limited, and all examined studies are more than 20 years old (Loomis & White, 1996; Richardson & Loomis, 2009).

Despite the limitations of these studies, the methodology can be informative. These studies examined whether descriptive variables such as type of survey mode, a species' population size, and payment vehicle can be used to explain the WTP for threatened and endangered species in the United States. They found that variables, such as payment frequency, whether the respondent was a visitor or non-user, whether the species is a marine mammal or bird, a species' charisma, response rate, respondent type, year of study, whether the species had use and non-use values versus only non-use values, and type of species affect the WTP at a 1%, 5% or 10% significance level (Loomis & White, 1996; Richardson & Loomis, 2009).

A more recent study by Subroy et al. (2019) reviewed 109 WTP estimates for threatened species extracted from 47 studies conducted in 19 countries. Similar to the meta-analysis conducted by Loomis & White, this study examines the effect of explanatory variables on the WTP. They found that the WTP was significantly higher for threatened and charismatic species. Analyzing valuation studies of threatened species worldwide and not just from one region or country distinguished this study from meta-analyses of wildlife valuation literature done before. Thereby, it includes both CV and CE studies. Also, the effect on WTP of not previously considered variables, such as species' threat status, use of coloured photographs of species in a survey, and a country's development status, was tested. A limitation of this study is the limited incorporation of use-values in the meta-analysis (Subroy et al., 2019).

In 2009, McLennan et al. conducted a meta-analysis of existing wildlife valuation literature. It was the first international meta-analysis of wildlife ever conducted. McLennan et al. reviewed 91 separate value observations from 41 studies. She used a meta-regression to determine which variables influence the dependent variables related to wildlife benefits, WTP per person and value per animal. She found that the variables animal weight and the species' population size significantly affect the benefits' valuation. Also, she determined the mean values of the following three valuation categories: WTP per person, Damage cost per household, and Value per animal. (McLennan et al., 2009). As described before, in the meantime, Subroy et al. (2019) also conducted an international meta-analysis into wildlife valuation. However, this study does not include the valuation categories damage cost per household and value per animal.

In late 2020, Brander & Guisado Goñi (2021) started building a database that includes over 300 WTP estimates for more than 100 species. They are conducting a meta-analysis of WTP estimates for species conservation. Similar to the meta-analyses on wildlife valuation done before, they research the effect of different explanatory variables on the WTP. Their study will contribute to the existing literature on meta-analyses of wildlife valuation by adding an explanatory variable that measures how aesthetically attractive each species is. An online survey using simple image selection questions to determine the level of aesthetical attractiveness per species was conducted.

This study contributed in several directions to the existing literature on meta-analyses of wildlife valuation. It was conducted in close collaboration with Brander & Guisado Goñi. First, the efforts made by Loomis & White (1996), Richardson & Loomis (2009), McLennan et al. (2009), Subroy et al. (2019), and Brander & Guisado Goñi (2021) were carefully analyzed and comprised into one comprehensive database. All studies included by one or more of these former meta-analyses were precisely evaluated whether these fit this study's in- and exclusion criteria. Thereby, as described in the methodology, this research looked into various explanatory variables. These explanatory variables might differ from the variables used in the former meta-regression analyses of wildlife valuation. Like McLennan et al. (2009) and Subroy et al. (2019), this research has an international scope. By including use values of wildlife, wildlife species that are not endangered, and studies published until 2020, this study distinguished from Subroy et al. (2019). Besides updating these former meta-analyses, this study contributes to an overarching project that seeks to provide insight into the tension between the benefits and costs of wildlife. As far as known, this is the first meta-analysis on wildlife valuation literature ever conducted that addresses the total value of wildlife, including the costs of the HWC.

3 Methodology

The literature has shown that one needs to look beyond market prices to explain the benefits of wildlife because market prices only express the use-values of ecosystem services. Non-use values have to be taken into account as well to determine the total benefits of wildlife. Stated preference methods such as CV or CE are examples of valuation methods that can value both use and non-use values. Surveys using such methods result in WTP values that can disclose all existing types of values described in chapter 2 (Marre et al., 2015).

3.1 Conceptual model

The model presented in Figure 2 is used to backbone this study aiming to find out what lessons can be learned from WTP values in existing wildlife literature. The dependent variable WTP is the core of the model. The value per animal derived from the WTP is also part of the core. The independent variables presented in the ring are tested on whether these significantly influence the dependent variables in the core. These variables can be divided into the following categories: animal, study, demography, and payment. The independent variables included in this study's meta-analysis were selected after evaluating other meta-analyses on wildlife valuation (Loomis & White, 1996; McLennan et al., 2009; Richardson & Loomis, 2009; Subroy et al., 2019). In Table 2, the presented variables are described in detail.

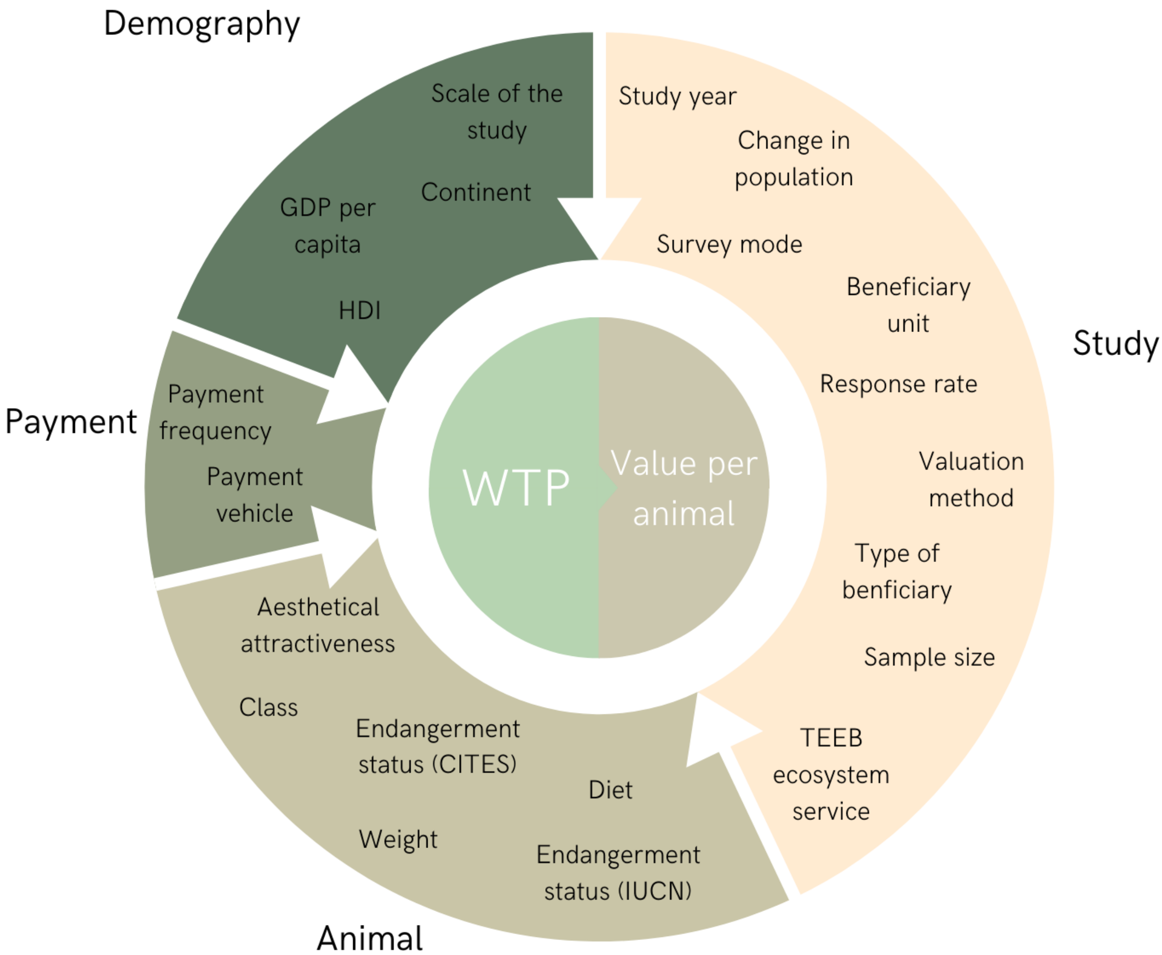

Figure 2 Conceptualized framework visualizing the independent variables and dependent variable that were included in the meta-regression analysis. The independent variables are presented in the ring divided into the following categories: animal, study, demography, and payment. The dependent variable WTP is shown in the core of the model together with its derived value per animal.

Table 2 Description of the independent variables that were tested on whether these significantly influence the WTP.

Category	Variable	Description	Unit
Study			
	Study year	Year in which the study was conducted	Year
	Valuation method	The valuation method used in the study to determine the WTP	Categorical
	Sample size	Number of valid survey responses	Categorical
	Response rate	Percentage of people who completed the survey	Percentage
	Beneficiary unit	Whether the WTP is per person or per household	Categorical
	Type of beneficiary	Description of the type of respondents	Categorical
	Change in population	The direction of the change of the species' population presented in the survey	Categorical
	Survey mode	Type of survey mode used	Categorical
	TEEB ecosystem service	Type of ecosystem service(s) that was/were studied	Categorical
Animal			
	Endangerment status (IUCN)	The level of endangerment of the species in the study year (According to IUCN's red list)	Categorical
	Endangerment status (CITES)	The level of endangerment of the species in the study year (According to CITES' appendices)	Categorical
	Class	Type of class of the species	Categorical
	Aesthetical attractiveness	A measure of how aesthetical attractive a species is	Percentage
	Diet	Diet of the species	Categorical
	Weight	Weight of the species	Categorical
Payment			
	Payment frequency	How often respondents were asked to contribute	Categorical
	Payment vehicle	In what way respondents were asked to contribute	Categorical
Demography			
	Continent	Continent on which the study was conducted	Categorical
	GDP per capita	A country's economic output divided by its population in the study year	US Dollars 2021
	Scale of the study	Scope of the study	Categorical
	Human Development Index (HDI)	A measure of how developed a country was in the study year	Categorical

3.2 Meta-analysis

The original definition of meta-analysis by Glass reads as follows: "The statistical analysis of a large collection of results from individual studies for the purposes of integrating the findings." (van Houtven, 2008). In the last 30 years, the interest in meta-analyses increased exponentially. In the 90s, a search for titles about meta-analysis published in the last five years yielded only 600 titles on PubMed (Dekkers, 2012). In 2021, the exact search yielded more than 117,000 titles. The increased emphasis on proof and evidence's weight is a fundamental reason for this growth in interest. Meta-analysis is one of the highest forms of evidence. Another reason is the relatively low cost and short time needed to conduct a meta-analysis (Dekkers, 2012).

Performing a meta-analysis was mainly used in the field of health sciences and medical research as a way to synthesize findings from an ever-growing body of medical trials. Resulting in most of the tools, techniques and protocols developed for conducting a meta-analysis are especially well suited to medical research requirements. Regardless, since the early 1990s, meta-analysis has become more widely used in social studies, including valuation research (van Houtven, 2008). Van Houtven (2008) presents an overview of the meta-analytic tools, techniques and protocols that are especially important and appropriate for analyzing WTP data. The methodological framework in Figure 3 visualizes what steps were taken to conduct the meta-analysis described in this paper. The presented steps were inspired by the stages of doing a meta-analysis of WTP data described by van Houtven (2008).

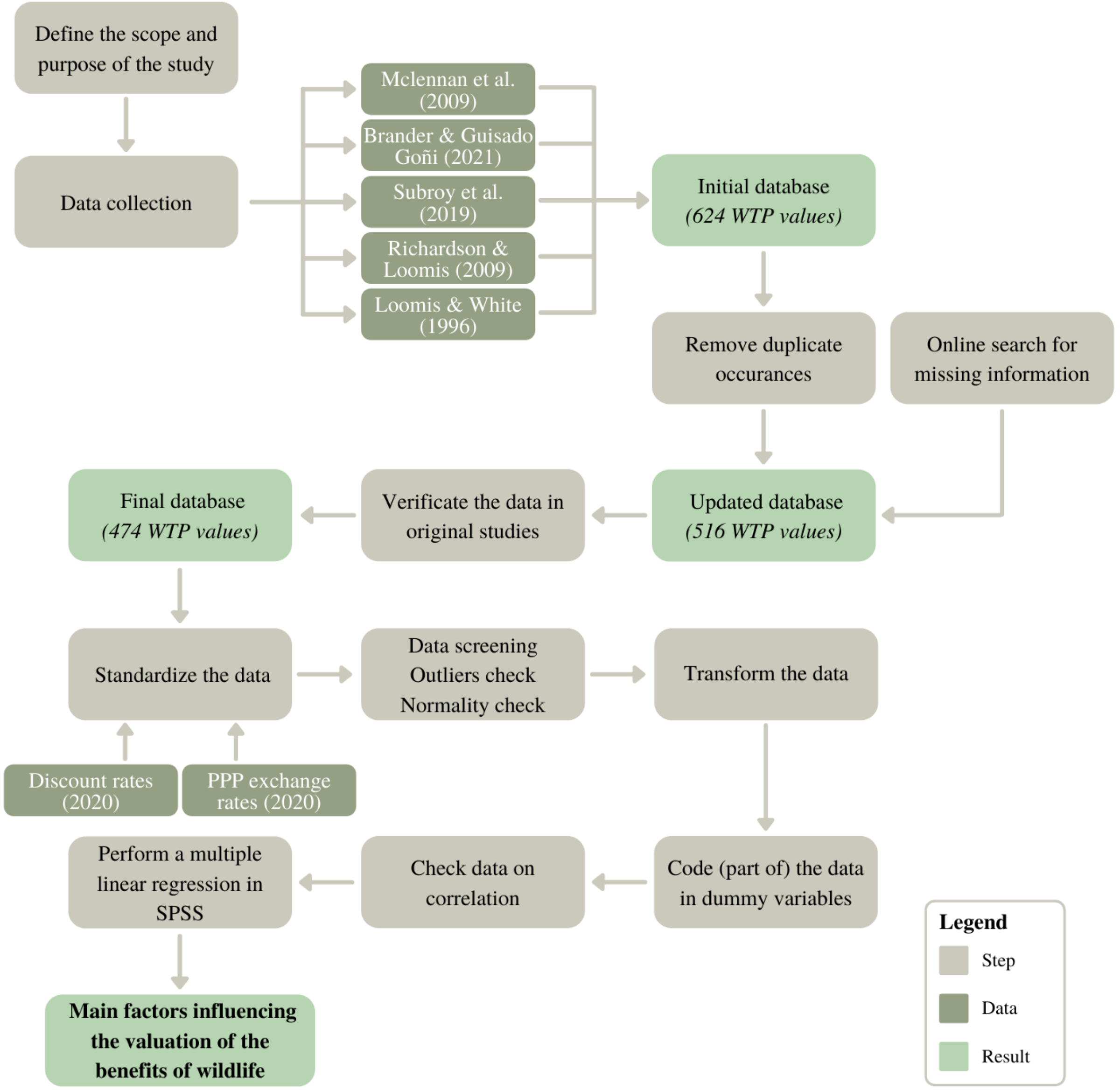

Figure 3 Methodological framework visualizing the steps taken to conduct a meta-analysis of existing wildlife valuation literature to determine the main factors influencing the benefits of wildlife.

3.2.1 Problem formulation

A precise formulation of the scope and purpose of the study conducted was needed before starting. First, the problem addressed and how the study contributes to it was clearly defined. Second, a thorough literature review helped to position the study within the existing literature on the topic. A literature review guarantees the novelty of the study. Furthermore, the primary objectives were defined in clear and challenging research questions. Chapters 1 and 2 of this thesis are devoted to the problem formulation.

3.2.2 Data collection

After defining the scope and purpose of the study, a procedure was set up to identify and gather all existing wildlife valuation literature that provides WTP estimates and meet the inclusion criteria. The term wildlife had to be clearly defined before the collection of the data. A definition is required to determine which studies to include. Traditionally, wildlife was defined as non-domesticated animals that could be hunted for leisure or food provision. More recently, all non-domesticated and non-cultivated animals and plants were included in the definition. To exclude the large number of literature on the economics of biodiversity and the economics of invasive species, a more narrow definition of wildlife was used (Gren et al., 2018). In this meta-analysis, all variables found on animal species that are non-domesticated and non-cultivated were included.

The data collection started by merging the databases of previous meta-analyses conducted by Loomis & White (1996), Richardson & Loomis (2009), McLennan et al. (2009), Subroy et al. (2019), and Brander & Guisado Goñi (2021). The latter includes the most recently published studies as Brander & Guisado Goñi started to build up this database at the end of 2020. Google Scholar has been the leading search platform they used. All valuation studies that used primary data were included in the database. They also used snowballing to find more studies. Snowballing uses the references of a relevant study to identify additional interesting studies (Wohlin, 2014).

When all the values found in the before-mentioned databases were collected and merged into one database, the database consisted of 624 WTP values. All studies with duplicate occurrences were checked and removed so that each study occurs only once. In this step, 108 WTP values were removed from the database, resulting in a database of 516 WTP values. For some of the independent variables that were to be included in the meta-regression, parts of the data were provided in neither the databases nor in the original studies. These independent variables include GDP per capita, Human Development Index, Population size, CITES endangerment status, IUCN endangerment status, Diet, Weight, and Classes. For all these variables, the data was found in other sources than the study itself. The used sources to find this information are further specified in Appendix I.

As described, an attempt has been made to find all existing literature. However, there are a couple of reasons why generally not all existing data can be found. One of the main reasons, not all studies are published or easy to find. This is called publication bias, defined as the tendency to publish only relevant results (Field & Gillett, 2010). Another reason is the language barrier; only English studies are included in the database. It is found that statistically significant results are more likely to be published in English (Konno et al., 2020). Adding only English and published studies to the database excludes many studies that may influence the results. Also, due to time constraints, only studies available in the databases of one of the former meta-analyses on wildlife valuation were included in the database of this study. By spending more time and effort in finding studies, the database could have been more inclusive.

3.2.3 Data evaluation and abstraction

Once all relevant studies, the WTP estimates presented in these studies, and values to describe the explanatory variables were gathered, the collected data was evaluated. The existing databases of meta-analyses done before from which the data was extracted used different formats and data collection methods. Therefore, all variables and WTP estimates were verified in the original studies. When a value could not be verified or was not explicit, the found value was discarded. It resulted in a final database of 474 WTP values from 110 wildlife valuation studies. The studies that were included in the database are further specified in Appendix II.

After that, the WTP values were standardized. The standardization is required to run a regression analysis and define the descriptive statistics. The WTP values in the database were discounted to incorporate changes in annual price levels (University of Minnesota, 2016). Discount rates provided by de Groot et al. (2020) were used to converse all WTP values to the 2020 price level. The collected WTP values were studied in various countries and years. Multiple currencies were used to express WTP. Also, the absolute purchasing power of inhabitants in each country differed. Purchasing power parity (PPP) factors incorporate these differences. The PPP exchange rate is defined by Tim Callen (2020) as: "The rate at which the currency of one country would have to be converted into that of another country to buy the same amount of goods and services in each country". The 2020 PPP exchange rates provided by The World Bank (n.d.) were used to convert the values from local currencies to US Dollars and account for different study areas' absolute purchasing powers.

It was decided not to transform the WTP values to the same beneficiary unit or payment frequency. Therefore, WTP values in the database can be per person or per household and can be expressed as an annual, a total or a one-time payment. This might affect the results of the regression analysis. Although to standardize the data, different assumptions should be made, as not all information needed was provided. Such assumptions can also influence the results. The different types of beneficiary units and payment frequencies were included in the regression analysis as dummy variables to account for the differences.

Then, a frequency distribution of the data was made to screen the data for errors (Universiteit van Amsterdam, 2021a). After that, a normality and outliers check were conducted. In the ideal situation, all continuous data would be normally distributed. However, the data can be negatively or positively skewed when the distribution is asymmetrical towards the right or left end of the distribution. Thereby, the sharpness of the peak of the distribution, also called kurtosis, can be too pointy or flat. A normal distribution has a skewness and kurtosis close to 0. For this regression, values between -1 and +1 were acceptable. Explanatory variables that appeared to have a high skewness or kurtosis were transformed into categorical variables. The distribution of the WTP data was positively skewed and too pointy. Therefore, the WTP variable was transformed using the natural log (Ln). It resulted in a more normally distributed variable (Universiteit van Amsterdam, 2021b). After that, the WTP data was checked on outliers and contained a couple of relatively high WTP values. However, these were not excluded as valid reasons exist why some values are high (Universiteit van Amsterdam, 2021c).

3.2.4 Data preparation

Besides continuous data, the database also included discrete data. Independent variables can be discrete, as long as these are encoded in dummy variables (Laerd statistics, n.d.-a). Dummy variables represent the different subgroups of a discrete variable (Trochim, 2020). As a general rule, the number of dummy variables per discrete variable is one less than the number of categories. The remaining category acts as a reference category. Regression analysis results in a coefficient for each of the independent variables. The resulting coefficients of the dummy variables represent the difference between the reference category and the category that the dummy variable represents (Laerd statistics, n.d.-a).

As the first step of the data preparation phase, discrete variables were converted into dummy variables. After that, all variables were checked on correlation. Highly correlated variables can seriously distort the regression analysis. SPSS was used to determine the Pearson Correlation Coefficient between the variables in the dataset. A correlation coefficient above 0.7 or below -0.7 indicates a strong linear relationship between two variables (Ratner, 2009). For all pairs of variables that appear to be highly correlated, only one variable was included in the final model (Scheaffer et al., 2010).

3.2.5 Data analysis

A regression analysis was conducted to determine which independent variables are significant at a 1%, 5%, or 10% level in a model that describes the WTP. Regression analysis is the process of finding a mathematical equation that represents the relationship between two or more variables. Multiple linear regression is used to model the linear relationship between two or more independent variables and a dependent variable. The general form of such a relationship is

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k + \varepsilon$$

The dependent variable Y is described as a function of k independent variables ($x_1, x_2, ..., x_k$). The error term ε incorporates a deviation between the deterministic part of the model, $\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k$, and the dependent variable Y. The values of the coefficients ($\beta_1, \beta_2, ..., \beta_k$) determine the contributions of the independent variables (x_1, x_2, ..., x_k). β_0 is the intercept of the model (Scheaffer et al., 2010).

On the advice of Brander, an expert in meta-regression analyses, it was decided to do a standard multiple linear regression. SPSS was used to model the linear relationship between the dependent variable WTP and the independent variables included in the database. SPSS allows determining the model's overall fit, how well the independent variables describe WTP, and each independent variable's relative contribution (Laerd statistics, n.d.-b). However, different functional forms of the estimating equation can be considered (van Houtven, 2008). Other functional forms might result in a more precise model. However, a simple linear model is sufficient to determine which independent variables affect the WTP.

3.2.6 Presentation of results

Once the regression was executed, SPSS provided the following three tables: the model summary table, the ANOVA table, and the coefficients table. The model summary table provided the multiple correlation coefficient (R), the coefficient of determination (R^2), also called R-squared, and the adjusted R-squared. The multiple correlation coefficient measures the quality of the prediction of the dependent variable. The R-squared represents the percentage of the variance in the dependent variable that can be explained by the independent variables (Laerd statistics, n.d.-b). In general, the higher the R and the R-squared, the better the overall fit of the model. The adjusted R-squared measures whether additional independent variables contribute to the model (Corporate Finance Institute, n.d.). The ANOVA table presented the F-ratio and the corresponding p-value; these measure whether the constructed model is a good fit for the data (Institute for Digital Research & Education, n.d.). Lastly, the coefficient table displayed the coefficients of all independent variables and the statistical significance of these coefficients. Unstandardized coefficients denote the change of the dependent variable when the independent variable increases by one unit (Laerd statistics, n.d.-b).

3.3 Value per animal

The value per animal was determined for species that were studied to have both positive and negative social impacts. Figure 4 visualizes the steps that were taken to determine the value per animal. To determine the species for comparison, the study results of both this study and Elmendorp’s study were used. As mentioned before, Elmendorp conducted a meta-analysis on existing literature valuing the negative social impacts of wildlife. As part of this, a database was composed with all values describing the negative social impacts of wildlife. A total of 57 species were included. These species are compared to the species included in the database composed for this study into the benefits of wildlife. The matching species were selected for comparison.

Values for the target population, the WTP per person or per household, and the species’ population size were needed to determine the benefits per animal for the selected species. The original studies were reviewed to find this information. An online search was conducted for information that could not be found in the original studies. The aggregated WTP could be found by multiplying the WTP per person or household by the number of persons or households in the target population. The aggregated WTP expresses the total benefits of a particular species in a certain study area. The value per animal was found by dividing the aggregated WTP by the number of animals living in the study area.

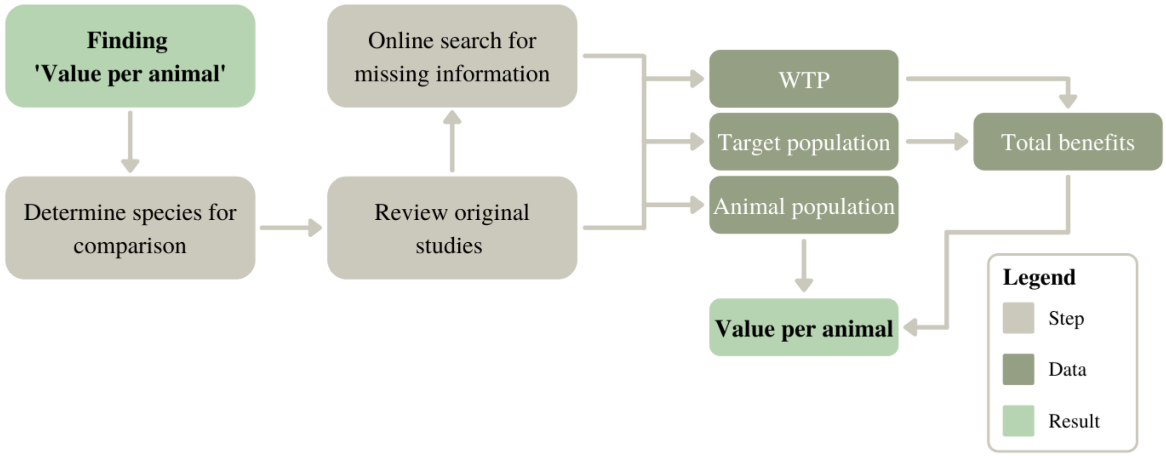

Figure 4 Methodological framework visualizing the steps taken to determine the value per animal for species that were studied to have both positive and negative social impacts.

It is not favourable to determine a total net value per animal by subtracting the costs from the benefits. The values are highly influenced by the size of the target population and the study design. For example, a study with a local scope is likely to find a much lower aggregated WTP than a study with a national scope. Usually, the target population consists of a lower number of people or households in local studies. However, a value per animal, either the costs or the benefits, is more intelligible for a wider audience than WTP or WTA values. Thereby, it can provide exciting insights into how the costs compare to the benefits.

Textbox: Species attractiveness survey

One of the explanatory variables included in the meta-regression was thr species' aesthetic attractiveness. Based on the results of an online survey using simple image selection questions, this variable measures how attractive people consider each animal species to be. The survey was designed by Brander and Guisado Goñi using Alchemer and conducted in collaboration with Elmendorp and van Beukering. Respondents were presented with a pair of animal species and asked to select the most 'aesthetically pleasing' animal of the two. An example of the questions asked is presented in Figure 5.

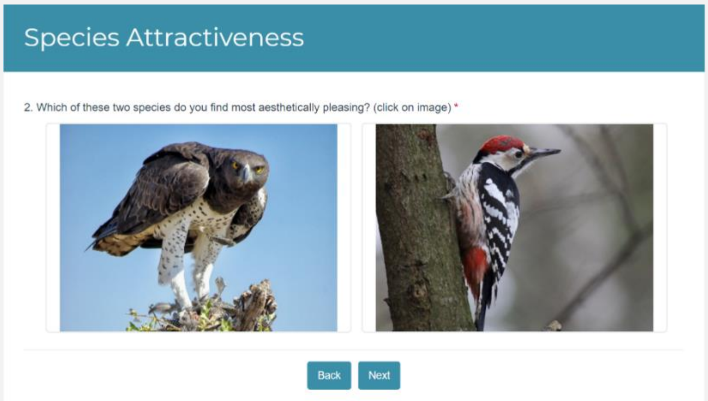

Figure 5 Example of one of the image selection questions that appeared in the species attractiveness survey.

Each respondent was asked to answer 20 of such questions randomly generated from 200 possible pairs of species. The survey was distributed globally via the personal social networks of those involved in the survey and ultimately brought 436 respondents. The survey results culminated in data describing the frequency with which each species appeared in the completed surveys and the total number of times a given species was selected as the most aesthetically pleasing. This data was then used to calculate a percentage describing how often a species was chosen. These percentages were then included in the database and the meta-regression as explanatory variables to check whether this per cent value significantly influenced the species' value positively or negatively. The survey found that the least aesthetically attractive species is the Pacific Ocean Perch. It appeared 38 times but was not selected once as the most attractive species of the two. The most aesthetically attractive species is the North Pacific Right Whale, followed by the Indochinese Tiger with scores of 94.9% and 94.1%, respectively.

It is essential to consider some methodological issues regarding the survey's sample size and bias in interpreting these outcomes. Determining whether a survey's sample size is large enough to ensure validity depends on various factors, including the size of the research population and the level of accuracy to be achieved (Faber & Fonseca, 2014). As everyone was welcome to complete the survey, the research population of this survey was not clearly defined and could potentially be very large. Sample size calculators provided by SurveyMonkey, Qualtrics, and Survey System advise a sample size of 385 at a confidence level of 95%, a margin of error of 5%, and a large population size of over 1,000,000. Based on this, it can be concluded that the survey's sample size is large enough. However, not all respondents completed the exact same survey, as they were asked 20 randomly generated questions. As a result, the frequency with which different animal species appeared in the survey ranged between 24 and 237 times. Therefore, it can be argued that a count of 24 appearances is insufficient to measure the attractiveness of a given species.

Furthermore, the attractiveness of each species is highly influenced by the other species that is shown. Suppose the survey presents two species that are both expected to be considered aesthetically attractive. In that case, this will likely result in an approximately equal number of choices for both species. However, suppose the respondent is asked to choose between a species that is expected to be considered attractive and another that is not. In that case, the outcome will likely result in a clear preference for the first species, so their overall ranking will increase. Finally, the quality of the images used might influence the results, as respondents are expected to prefer a high-quality image independent of the species presented. To prevent a bias based on the quality of the image, it was attempted to select images of equally high quality.

4 Results

4.1 Description of the data

The final database consists out of 110 studies that provide 474 WTP estimates. Below, the payment, study, demographic, and animal characteristics of the data are visualized and described. Furthermore, the descriptive statistics of the WTP data are presented.

4.1.1 Payment characteristics

Figure 6 provides an overview of the payment characteristics of the dataset. In the original studies, the WTP values are expressed in different currencies. The ten most used currencies to express WTP and their number of appearances are presented in inset A of the infographic. Another differing factor among stated preference studies is in what way respondents were asked to contribute. Six different payment vehicles were used for the data included in the database. The pie chart in B presents how often each of the different payment vehicles occurs. Lastly, inset C provides information on the payment frequency. More than three-quarters of the WTP values are expressed in a yearly contribution.

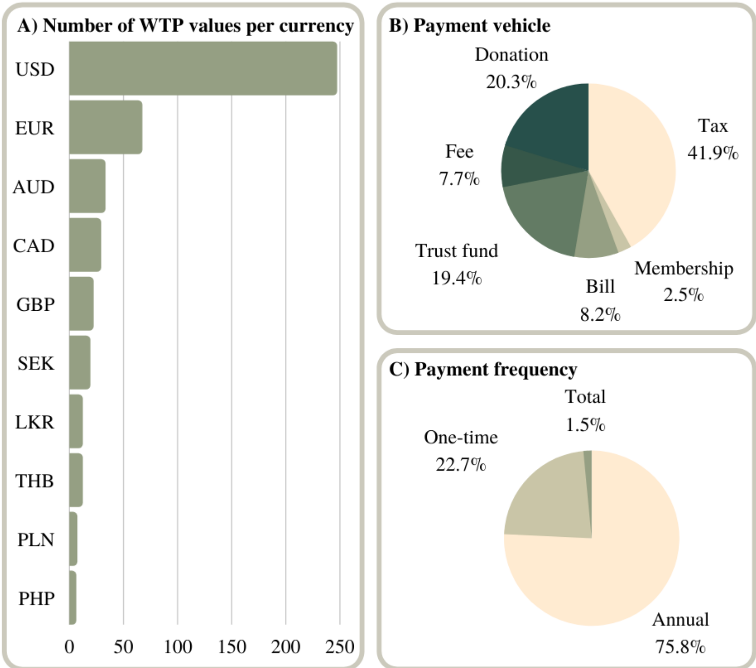

Figure 6 An overview of the payment characteristics of the WTP values included in the database. Inset (A) reveals the most common currencies used to express the WTP values and their number of appearances. The pie charts (B) and (C) provides information on what payment vehicles were used to determine the WTP and the payment frequency of the WTP values, respectively.

4.1.2 Demographic characteristics

Figure 7 shows the study locations of the WTP values included in the database. Africa and South America are underrepresented in the database because almost no studies were conducted in these continents that matched the inclusion criteria. Also, only 1.9% of the WTP values were studied in low developed countries. These low developed countries are primarily in Africa (UNCTAD, n.d.). Most of the values in the database are studied in wealthier countries such as The United States, Canada, and Australia. The ten most common countries and their number of appearances in the database are presented in inset B of the infographic. Inset C in Figure 7 provides an overview of the distribution of the GDP per capita; this variable appears to be relatively normal distributed. Lastly, the number of WTP values included in the database is equally distributed over the different scopes except for the multi-country scope. Only 2.1% of the WTP values are studied on a multi-country level.

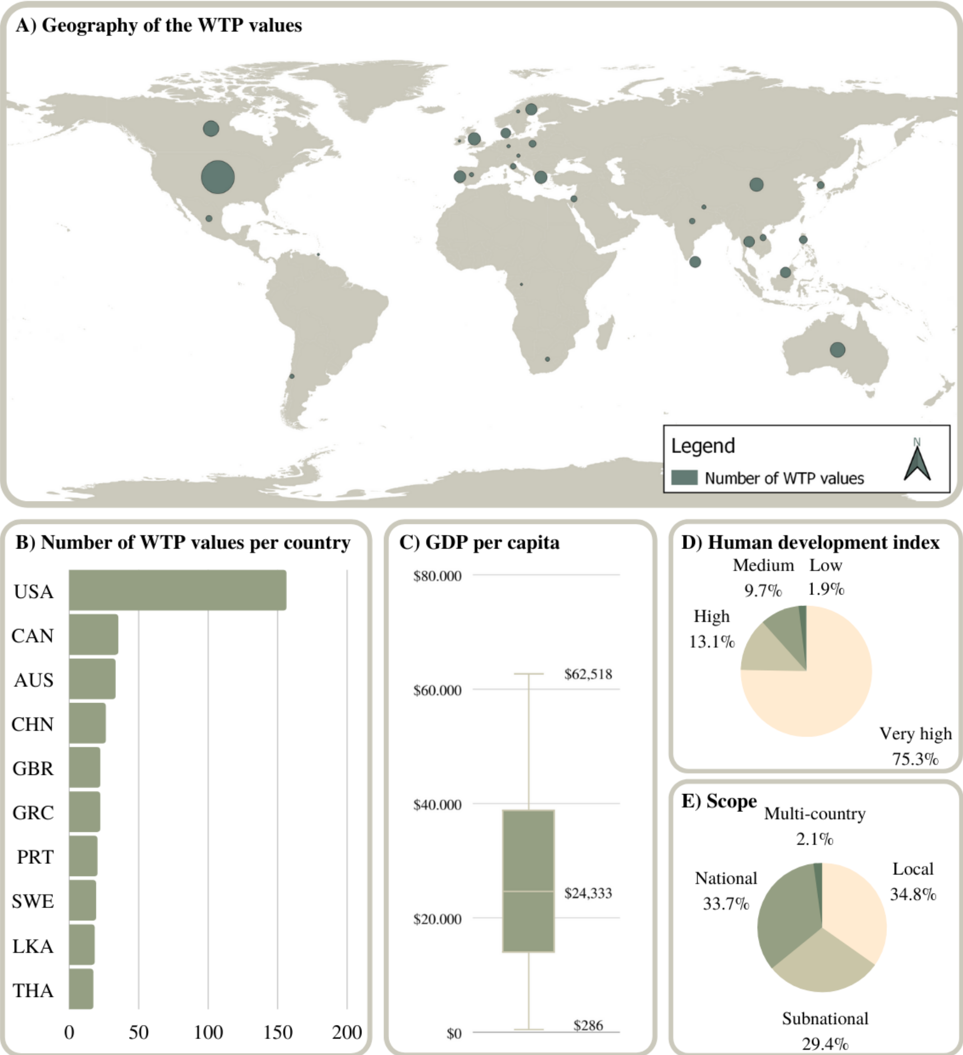

Figure 7 An overview of the demographic characteristics of the WTP values included in the database. (A) shows in which countries the WTP values were studied. The size of the green dots indicates the number of WTP values per country. Inset (B) reveals the most common countries in the database and their number of appearances. (C) shows the distribution of the GDP per capita during the time of the study. The pie charts (D) and (E) provide information on how well-developed countries were during the time of the study and on what scope the WTP values were determined, respectively.

4.1.3 Study characteristics

Figure 8 displays the characteristics of the studies conducted to determine the WTP values included in the database of this study. First, it is shown what type of respondents was asked to determine WTP. People that live in or close to the study area were most often asked to express their WTP. Studies that study the WTP for species appearing in other countries than the respondents' home countries are the least common. CV appears to be more commonly used than CE to value WTP. The number of WTP values expressed per person is almost equal to the number of WTP values expressed per household. Inset D presents in which periods the WTP values were studied. Most studies were conducted in the period between 2005 and 2010. The boxplots display the distributions, median, minima, and maxima of the conducted studies' response rates and sample sizes. The response rate appears to be relatively normally distributed. The sample size data contains high outliers. Inset G presents the direction of change in the population of a species asked to determine WTP. It is shown that the WTP questions in surveys mostly ask for an increasing population size. Thereby, different survey modes were used to determine WTP. Most studies were conducted in person or by mail. Lastly, there are different types of ecosystem services that were valued. Most valuation studies focus on valuing existence, bequest values.

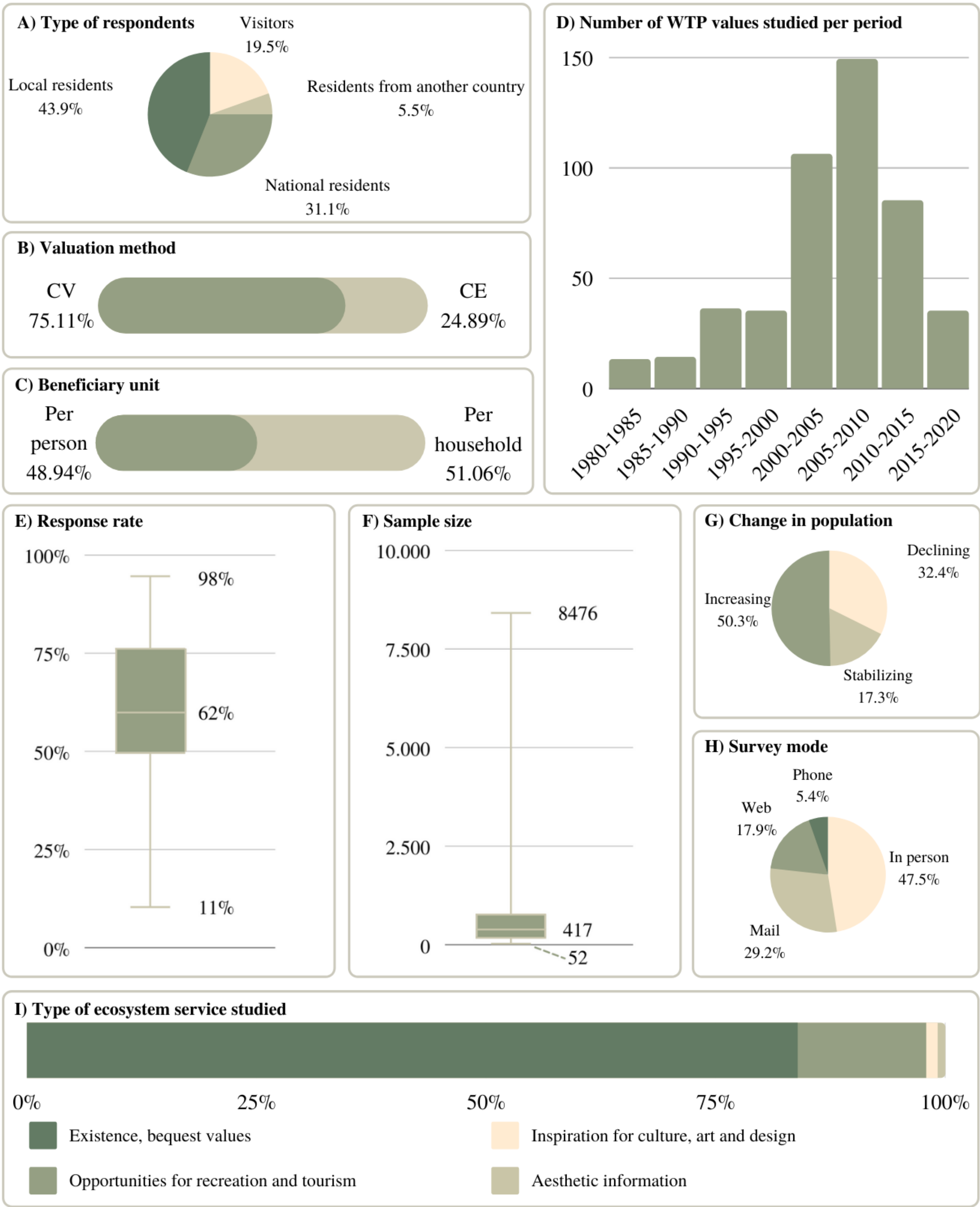

Figure 8 An overview of the study characteristics of the WTP values included in the database. (A) shows the type of respondents that were asked to express their WTP. The bars (B) and (C) express information on how often each valuation method was used and whether the WTP values were asked per person or per household, respectively. The bar chart (D) shows how many studies were conducted in each period of five years between 1980 and 2020. The boxplots (E) and (F) display the distributions of the response rates and sample sizes, respectively. The pie charts (G) and (H) provide information on the direction of the change in population that respondents were asked to value and the different types of survey modes used to conduct the surveys, respectively. The bar chart (I) presents the different types of ecosystem services that are valued in valuation literature.

4.1.4 Animal characteristics

Figure 9 provides an overview of the animal characteristics of the dataset. The bar graphs in insets A and B present information about the endangerment statuses of the animals during the time of the study. It appears that most species included in valuation studies were listed in Appendix I of the CITES Appendices. Appendix I lists the most endangered species of the CITES-listed animals (CITES, n.d.). These findings align with the presented IUCN red list statuses; most species appear to be listed as endangered during the time of the study. The ten most appearing species and their number of appearances are presented in inset C of the infographic. Lastly, it appears that carnivores, large animals (100+ kg), and mammals are most often included in studies valuing the benefits of wildlife. Omnivores, medium animals (40 – 100 kg), and invertebrates are the least popular to be included in such studies.

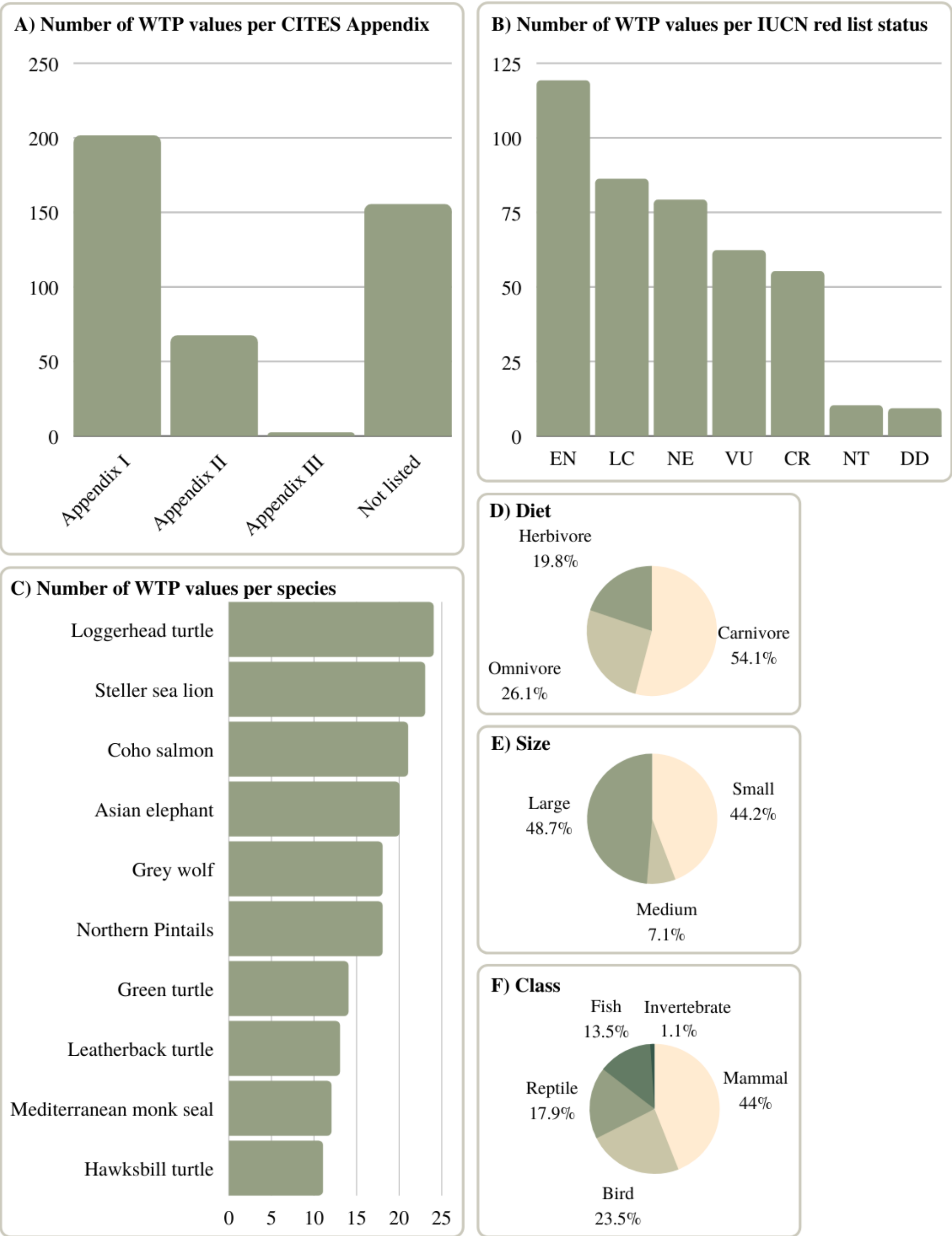

Figure 9 An overview of the animal characteristics of the WTP values included in the database. The bar charts (A) and (B) show the number of WTP values in each of the CITES Appendices and IUCN red list status categories, respectively. Inset (C) reveals the most common species in the database and their number of appearances. The pie charts (D), (E), and (F) provide information on the diet, size, and class of the species, respectively.

4.2 Descriptive statistics of the WTP data

Figure 10 provides an overview of the descriptive statistics of the WTP data. The database includes WTP values in different beneficiary units and payment frequencies. Therefore, a boxplot and the corresponding statistics are presented for each of the combinations between the different beneficiary units and payment frequencies, resulting in the following categories: annual WTP per household, annual WTP per person, one-time WTP per person, and one-time WTP per household. The total WTP values, one of the possible payment frequencies, are not included in the infographic due to a lack of data. Almost half of the valuation studies appear to present annual WTP per household. The one-time WTP per household values are the most normally distributed of the four. The other categories contain relatively high outliers causing the boxplots to be malformed. The averages and medians of the one-time WTP values appear to be higher than these of the annual WTP values. The mean and median of all collected WTP estimates are $86.26 and $48.57, respectively. The lowest WTP value included is $0.04. The highest WTP value included in the database is $1829.43. Both values belong to the annual WTP per household category. The range between the highest and lowest WTP value is $1829.40.

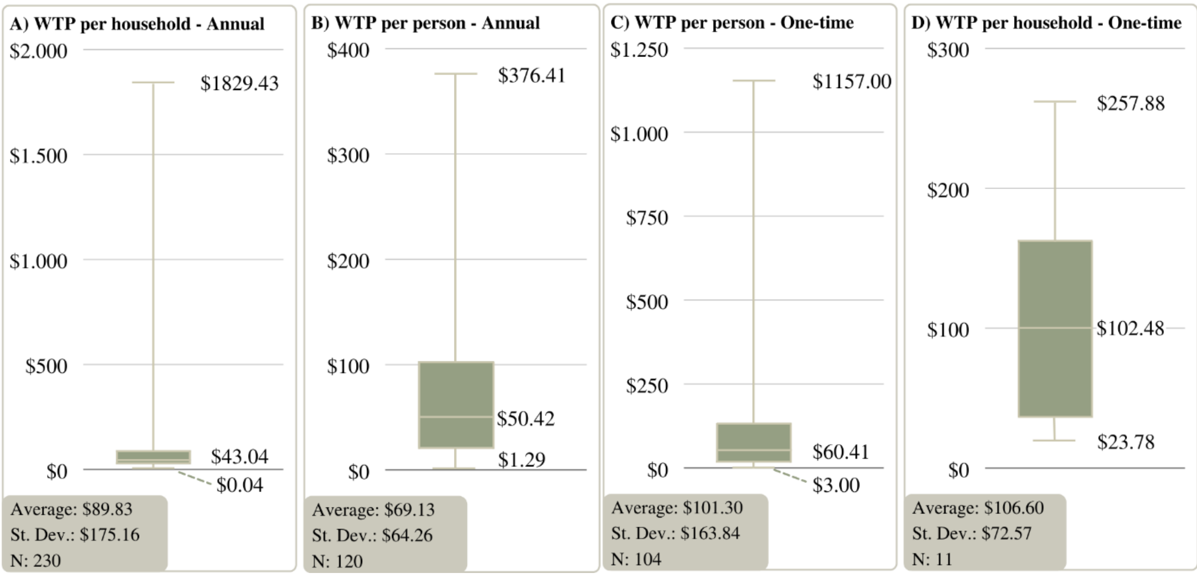

Figure 10 An overview of the descriptive statistics of the WTP data. A boxplot displaying the distribution, median, maximum, minimum, mean, standard deviation, and sample size is shown for each of the following categories: (A) Annual WTP per household, (B) Annual WTP per person, (C) One-time WTP per person, and (D) One-time WTP per household.

4.3 Meta-Regression results

As described in the methodology, a meta-regression in SPSS results in a model summary table, an ANOVA table, and a coefficients table. The information provided by these tables is presented in Table 3. The constructed model appears to predict over 92% of the variation in the dependent variable ln(WTP). The F-ratio with a p-value of 0.000 indicates that the independent variables presented in Table 3 reliably predict the ln(WTP). The factors that significantly affect the ln(WTP) are: whether the WTP was asked per person; whether the survey was conducted by phone; whether the survey was conducted in Asia; whether the scope of the survey was sub-national; whether the payment vehicle was an increase in bills; whether the payment vehicle was a donation; whether a species was included in the CITES Appendix II during the study period; whether a species was not listed in the CITES Appendices during the study period; whether a species was placed in the least concern category of the IUCN red list during the study period; whether a species is a carnivore; whether a species falls into the medium weight category; whether a species belongs to the birds; and lastly, whether the payment asked for was a one-time payment. All these factors are coded as a dummy variable and compared with a base category. These base categories are presented in Table 3 for each of the variables.

Table 3 Coefficients table of the multiple linear regression with ln(WTP) as the dependent variable

Independent variable	**Coefficient**	**P-value**
Study		
CE *(base: CV)*	-5.718	0.157
Small sample size *(base: Large sample size)*	0.645	0.354
Response rate	0.024	0.279
National resident *(base: Local resident)*	0.284	0.654
Visitor *(base: Local resident)*	-0.050	0.936
Per person *(base: Per household)*	1.540**	0.033
Decreasing population size *(base: Increasing population size)*	0.185	0.599
Maintaining the population size *(base: Increasing population size)*	-0.374	0.198
Mail *(base: In person)*	-0.204	0.832
Web *(base: In person)*	-0.733	0.823
Telephone *(base: In person)*	4.299*	0.086
Opportunities for recreation and tourism *(base: Existence, bequest values)*	3.509	0.126
Demography		
Asia *(base: North America)*	16.309*	0.088
Europe *(base: North America)*	-0.898	0.536
National *(base: Local)*	-0.259	0.746
Multi-country *(base: Local)*	14.905	0.295
Subnational *(base: Local)*	1.349*	0.090
GDP per capita (USD2021) during study period	-4.4E-05	0.635
Medium human development *(base: Very high human development)*	-17.149	0.166
Payment		
Bill *(base: Tax)*	-4.679***	0.008
Donation *(base: Tax)*	2.114**	0.044
Membership *(base: Tax)*	-4.302	0.218
Trust fund *(base: Tax)*	-2.930	0.277
One-time payment *(base: Annual payment)*	-4.504**	0.016
Animal		
Appendix II *(base: Appendix I)*	2.282*	0.093
Not listed *(base Appendix I)*	2.155*	0.095
Least concern *(base: Endangered)*	-4.676**	0.015
Not evaluated *(base: Endangered)*	-3.591	0.106
Vulnerable *(base: Endangered)*	-4.865	0.146
Aesthetical attractiveness	0.050	0.294
Herbivore *(base: Omnivore)*	-2.736	0.172
Carnivore *(base: Omnivore)*	-2.404*	0.090
Medium weight *(base: High weight)*	-7.324***	0.005
Small weight *(base: High weight)*	-0.862	0.229
Bird *(base: Mammal)*	3.144**	0.014
Fish *(base: Mammal)*	1.581	0.323

Observations:	474	**Adj. R-squared:**	0.855
R:	0.961	**F-ratio:**	13.460 (p-value: 0.000)
R-squared:	0.924		

Note: Significance is indicated with ***, **, and * for the 1, 5, and 10 per cent level, respectively

The following warning appeared once the meta-regression was run using SPSS: "*For models with dependent variable ln(WTP), the following variables are constants or have missing correlations: Oceania, South America, High human development, Fee, Voluntary tax, Appendix III, Data deficient, Near threatened, Invertebrates, Reptile, Aesthetic information, Inspiration for culture, art and design, and Total payment."* Most of these variables appear to have a low number of observations. According to Brander, these variables appear to have no relationship with the WTP. Therefore, these variables were left out of the linear model describing the WTP.

4.4 Value per animal

Table 4 provides an overview of the costs and benefits per animal. Combining the database of this study with Elmendorp's database results in an all-encompassing database including all valuation studies into both the positive and negative social impacts of wildlife. The value per animal was determined for species that appeared in both databases; African elephant, Asian elephant, tiger, goose, and wolf were evaluated. Elmendorp found nine value observations on the annual costs per animal. This study contributed 20 benefits per animal value observations that are either annual or total values. All values are expressed in US dollars in the 2020 price level accounting for differences in absolute purchasing powers of the study areas. Table 4 provides insight into the fact that the costs per animal are relatively low compared to the benefits people experience from species.

Table 4 Overview of the costs and benefits per animal

Costs	Country	**Benefits**	Country
African elephant			
$43.60 per animal per year	Uganda	$427.80 per animal per year	WTP of Sweden for elephants in Africa
		$97,480.28 per animal per year	WTP of China for elephants in Africa
Asian elephant			
$12,379.24 per animal per year	China	$11,928.66 per animal per year	Sri Lanka
$95.12 per animal per year	India[1]	$78,875.29 per animal in total	Sri Lanka
$84.59 per animal per year	India	$565.99 per animal in total	Malaysia
		$36,672.69 per animal in total (voluntary)	Thailand[2]
		$8,265.90 per animal in total (mandatory)	Thailand[2]
		$608,643.54 per animal in total	Nepal
Tiger			
$115.53 per animal per year	India	$802,215.13 per animal in total (voluntary)	Thailand[2]
$1,405.77 per animal per year	India[1]	$180,816.74 per animal in total (mandatory)	Thailand[2]
Goose			
$24.66 per animal per year (endangered)	Scotland[3]	$120.73 per animal in total (endangered)	Scotland[3]
$25.23 per animal per year (all)	Scotland[3]	$29.60 per animal in total (all)	Scotland[3]
Wolf			
$420.56 per animal per year	Canada	$9,425,778.88 per animal per year	Sweden
		$4,394,696.83 per animal per year	Sweden
		$1,223,856.95 per animal per year	Sweden
		$1,632,712.11 per animal in total	United States
		$5,553.51 per animal in total (50% increase)	United States
		$1,983.40 per animal in total (300% increase)	United States
		$7,741.36 per animal in total (local residents)	United States
		$70,092.95 per animal in total (national residents)	United States

Note: Values indicated with a superscript originate from the same study

5 Discussion

5.1 Discussing the results

Below, the results are discussed concerning the sub-questions presented in the introduction.

Sub-question 1: What are the characteristics of the current literature on the valuation of wildlife?

It was decided to not transform the WTP data to one single beneficiary unit and payment frequency. Therefore, the descriptive statistics of the following four categories were determined: annual WTP per household, one-time WTP per household, annual WTP per person, and one-time WTP per person. The mean of the one-time WTP per household was found to be 106.60 US dollars (2020 PPP US$). This value is significantly lower than the mean total value of WTP for a threatened species of 414 US dollars (2016 US$) per household found by Subroy et al. (2019). These values differ in price levels, and Subroy et al. did not consider differences in absolute purchasing power among the study areas; both factors enlarge the difference between the two values. The fact that Subroy et al. just looked into endangered species could explain the difference between the mean values. This is in line with the findings of the conducted meta-regression that show that a species with the least concern IUCN red list status is valued lower than a species with an endangered IUCN red list status. The average annual WTP per person is found to be 69.13 US dollars (2020 PPP US$). McLennan et al. (2009) present a mean WTP per person per year of 33 US dollars (2005 PPP US$). Discounting the value of McLennan et al. to the same price level used in this study results in a mean WTP of 42.9 US dollars (2020 PPP US$). Despite a comparable research method, McLennan found a significantly lower mean value.

It is found that annual mean values are lower than one-time mean values, and mean values per person are lower than mean values per household. These findings are in line with the existing literature. However, the values found by Subroy et al. and McLennan et al. are undeniably higher and lower than the values found in this study. This could be explained by the fact that Subroy et al. and McLennan et al. transformed their values to one beneficiary unit and payment frequency. Assumptions had to be made to perform such transformations. For example, to transform a per person value to a per household value, the per person value is multiplied by the average number of persons per household. However, the question can be asked whether it is correct to assume that the WTP forms a linear relationship with the number of persons in a household. Transforming WTP values towards the per household unit might overestimate the WTP and the other way around. Thereby, the results of the meta-regression show conflicting results; whether the beneficiary unit is per person seems to positively affect WTP compared to when the WTP is expressed per household.

Other characteristics of the database are primarily in line with the characteristics of the database of McLennan et al. Nevertheless, the database of McLennan et al. contains: a higher share of studies conducted in Africa; a higher share of species that are CITES listed; a higher share of carnivorous species; and a lower share of large species of more than 100 kilograms. Differences could be explained by the fact that the database of McLennan et al. is outdated and also contains valuation studies on the negative social impacts of wildlife.

Sub-question 2: How do geographical characteristics affect the benefits of wildlife?

According to the meta-regression results, conducting a study in Asia positively influences the WTP. McLennan et al. and Subroy et al. do not report any significant geographical characteristics. The studies of Richardson & Loomis and Loomis & White have not tested any geographical characteristics as both studies only included wildlife valuation studies conducted in the United States. Another geographical factor that was found to influence the WTP significantly was the scale of the valuation study. It was found that studies with a subnational scope tend to positively influence the WTP results compared to studies with a national scope. This factor was not considered in one of the prior meta-analyses.

Sub-question 3: How does the endangerment status of a species affect its benefits?

Some of the findings of the meta-regression are in line with findings presented in previous meta-analyses of WTP for wildlife, namely the endangerment status, similar to McLennan et al. and Subroy et al. is found that the endangerment status significantly affects the WTP. The WTP for species labelled as "least concern" in the IUCN red list tends to be lower than the WTP for species labelled as "endangered". Species included in Appendix II or that were not CITES-listed are higher valued than species included in Appendix I of the CITES Appendices. The results of the IUCN red list and CITES Appendices variables contradict each other. For the IUCN red list status holds that the more a species is endangered, the higher it is valued. According to the results, the opposite is true for the CITES Appendices. Both McLennan et al. and Subroy et al. endorse the results found for the IUCN red list status.

Sub-question 4: How do the characteristics of how a valuation study is conducted affect the benefits of wildlife?

It is found that study characteristics such as response rate and sample size do not significantly influence WTP; meta-analyses did before present similar findings. Furthermore, the results show no significant influence of variables describing the survey, namely the valuation method used and the direction of the change in population size. All other meta-analyses mentioned in chapter 2 did report these variables as significant. Other than Loomis & Richardson, which presented surveys distributed by mail to affect WTP negatively, it is found that surveys conducted by phone result in higher WTP values. Thereby, it is found that the type of payment vehicles seems to be essential; these results contrast with the study conducted by Subroy et al. In general, it is found that the different choices that need to be made when conducting a stated preference study affect the results. When designing such a study or interpreting the results of such a study, one should take these findings into account.

Sub-question 5: How do the characteristics of a species affect its benefits?

Variables that describe the characteristics of the valued species appear to influence WTP. For example, people are willing to pay less for carnivores than for omnivores. McLennan et al. found no significant influence of the diet of species on WTP. Species that belong to the class of birds are valued more positively compared to mammal species. Richardson & Loomis and Subroy et al. have explicitly looked into the effect of marine mammals and found this to be significant. This category has not been studied in this study. It is found that medium-sized animals are valued lower than large-sized animals. McLennan et al. observed that small mammals are valued higher. These findings can facilitate determining the value of a particular species without doing time-consuming and costly research. It will not be possible to determine an exact value for a species. However, the results can be used to compare different species based on their characteristics. The information can be used to prioritize public investments in projects to preserve wildlife.

Sub-question 6: How do the benefits per animal compare to the costs per animal?

The benefits per animal for the African elephant, Asian elephant, tiger, goose, and wolf were determined. These species were selected because they appear to be included in the database of this study, as well as in Elmendorp's database. Determining both the benefits and the costs for these species enabled the possibility to do a simple cost-benefit analysis. In general, the benefits are found to exceed the costs. However, the persons that appear to benefit from certain species usually do not experience the negative social impacts. It can be said that the distribution of the social impacts is unfair. Financial compensation to those who suffer from wildlife paid by those who benefit from wildlife might be a solution for this misalignment. Though, there is no one-size fits all solution appropriate for this problem. From case to case, a tailor-made solution should be found and implemented. The main purpose of this analysis was to identify the misalignment between those who benefit and those who suffer and to find out that the societal value of species vastly outweigh the damage costs that they may cause.

5.2 Limitations of the research

Throughout the paper, the methodological limitations have been explained, and arguments have been made about why certain choices have been made. Besides these limitations, the stated preference studies that were included in the database are increasingly criticized. Eberle & Hayden (1991) researched whether stated preference methods such as the contingent valuation method and travel cost method can be legitimized in a theoretical or applicable sense from a neoclassical, psychometric or general systems perspective. They found that such methods lack methodological, theoretical and empirical grounding. However, stated preference methods are still the only methods applicable for the valuation of goods or services that do not pass through markets and do not have substitutes or complements that pass through markets (Bann, 2002). Despite the limitations and weaknesses, stated preference methods are the only available option to determine the total value of ecosystem services. Excluding stated preference methods would lead to the elimination of non-use values in the valuation of ecosystem services. Non-use values should also be included in policymaking to get an overall picture of the situation. This research contributes to giving more openness to which factors are essential to consider when applying stated preference methods.

6 Conclusion

This research aimed to identify what factors influence the benefits of wildlife around the world. First, an all-embracing database of existing wildlife valuation literature was composed. All studies that present a WTP value valuing one or more wildlife species were included within the database. It resulted in a database containing 110 studies and 474 value observations. None of the meta-analyses of wildlife valuation done before included such a high number of studies and observations. It is not possible to present one single mean or median that correctly describes the data as the database includes WTP values in different beneficiary units and payment frequencies. The willingness to pay values in the database range from $0.04 to $1829.43 indicating the high variety in the values. The composed database was used as an input for the meta-regression analysis.

Based on the regression analysis conducted, it can be concluded that multiple factors influence the benefits of wildlife. The main factors found are the beneficiary unit, the survey mode, geographical location, geographical scale of the study, payment vehicle, endangerment status, diet of the species, size of the species, class of the species, and the payment frequency. Some of these factors are related to how a stated preference method study to determine the WTP is conducted. These findings should be considered in the designing process of future studies or when interpreting the results of conducted studies. Other factors relate to the type of species that is valued. These findings can be used for comparing the values of species. This information can help to prioritize public investments in projects to preserve wildlife.

The overarching project, of which this study is part, seeks to provide insight into the tension between the benefits of species conservation and the harm caused by such wildlife species. As part of this project, Elmendorp (2021) conducted a study into the negative social impacts of wildlife. A basic cost-benefit assessment was conducted to provide insight into how the benefits of wildlife compare to the costs of wildlife. For the species that appeared to be included in both studies, a positive, as well as a negative value per animal was determined based on the existing literature. In general, it was found that the positive social impact per animal exceeds the negative social impact per animal. These findings identify an opportunity to link those who benefit from species to those who experience harm from species. This would eventually lead to a fairer distribution of the social impacts of wildlife.

Finally, this study has created a strong foundation that can be used for further research. The database consisting of 474 WTP values could be extended by looking into other sources than the internet, studies published in other languages than English, and conducted surveys that are not officially published. Another recommendation for further research might be to apply other methodologies to the data. The statistical method used in this study is a simple multiple linear regression. Different statistical methods could be applied while doing a meta-analysis. Other meta-analyses on wildlife valuation used regression methods such as the backward stepwise regression, double log regression, and clustered robust regression (McLennan et al., 2009; Richardson & Loomis, 2009; Subroy et al., 2019). Therefore, the database composed for this study can be used to apply different statistical methods. Further research could provide insight into the most suitable method for finding a model that describes the data as accurate as possible. Lastly, the found results in this study could be used to study the application of wildlife valuation. An opportunity might be to translate the findings of this research and the research on the costs of wildlife conducted by Elmendorp (2021) into policy recommendations. As part of this, a more comprehensive cost-benefit analysis can be conducted by elaborating on the value per animal.

7 References

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Laerd statistics. (n.d.-b). *How to perform a Multiple Regression Analysis in SPSS Statistics*. Retrieved June 13, 2021, from https://statistics.laerd.com/spss-tutorials/multiple-regression-using-spss-statistics.php

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Appendix

Appendix I Sources used for missing information

Table A.I The sources used for finding the data for explanatory variables of which the data was not provided in the existing databases nor in the original studies

Explanatory variables	Source
GDP per capita	
	The World Bank. (n.d.). *GDP per capita (current US$) | Data*. Retrieved June 15, 2021, from https://data.worldbank.org/indicator/NY.GDP.PCAP.CD
Human Development Index (HDI)	
	United Nations Development Programme. (n.d.). *Download Data | Human Development Reports*. Retrieved June 15, 2021, from http://hdr.undp.org/en/content/download-data
Endangerment status (IUCN)	
	IUCN Red List. (n.d.). *IUCN Red List of Threatened Species*. Retrieved June 15, 2021, from https://www.iucnredlist.org/
Endangerment status (CITES)	
	UNEP-WCMC, & CITES Secretariat. (n.d.). *Species+*. Retrieved June 15, 2021, from https://www.speciesplus.net
Population size	
	Flinn, A. (n.d.). *Overview - Elephants in Thailand*. Retrieved June 25, 2021, from https://www.elephantnaturepark.org/about/about-elephants/
	Thouless, C. R., Dublin, H. T., Blanc, J. J., Skinner, D. P., Daniel, T. E., Taylor, R. D., Maisels, F., Frederick, H. L., & Bouché, P. (2016). *African Elephant Status Report 2016*.
Diet / Weight / Classes	
	Agraria. (n.d.). *Italian breeds of livestock*. Retrieved June 27, 2021, from http://eng.agraria.org/
	Animal Corner. (n.d.). *A-Z Animals Listing | A Complete List of Animals*. Retrieved June 27, 2021, from https://animalcorner.org/animals/
	Animal Diversity Web. (n.d.). *Home*. Retrieved June 27, 2021, from https://animaldiversity.org/
	Animalia. (n.d.). *Online Animals Encyclopedia*. Retrieved June 27, 2021, from https://animalia.bio/
	Bear Conservation. (n.d.). *Bears in the wild*. Retrieved June 27, 2021, from http://www.bearconservation.org.uk/the-bears/
	Britannica. (n.d.). *Mammals Portal*. Retrieved June 27, 2021, from https://www.britannica.com/browse/Mammals
	British Trust for Ornithology. (n.d.). *BirdFacts*. Retrieved June 27, 2021, from https://www.bto.org/understanding-birds/birdfacts
	Bush Heritage Australia. (n.d.). *Native Australian Species*. Retrieved June 27, 2021, from https://www.bushheritage.org.au/species
	Cattle Network - EAAP Working Group. (n.d.). *Cattle Network*. Retrieved June 27, 2021, from http://www.cattlenetwork.net/index.htm
	Committee on the Status of Endangered Wildlife in Canada. (2010). *Assessment and Status Report on the Atlantic Whitefish in Canada*. www.sararegistry.gc.ca/status/status_e.cfm
	Cornell Lab of Ornithology. (n.d.). *Bird Guide*. Retrieved June 27, 2021, from https://www.allaboutbirds.org/guide/
	Defenders of Wildlife. (n.d.). *Defenders of Wildlife*. Retrieved June 15, 2021, from https://defenders.org/

Department of Environment and Science, Q. (n.d.). *Threatened species | Environment*. Retrieved June 27, 2021, from https://environment.des.qld.gov.au/wildlife/threatened-species

East Asian - Australasian Flyway. (n.d.). *Home*. Retrieved June 27, 2021, from https://www.eaaflyway.net/

Edge of Existence. (n.d.). *Species*. Retrieved June 27, 2021, from https://www.edgeofexistence.org/species/

European Commission. (n.d.). *Species protection - Environment*. Retrieved June 27, 2021, from https://ec.europa.eu/environment/nature/conservation/index_en.htm

Florida Fish and Wildlife Conservation Commission. (n.d.). *Marine Fisheries Research*. Retrieved June 27, 2021, from https://myfwc.com/research/saltwater/

Focus Fishing. (n.d.). *Species Archive*. Retrieved June 27, 2021, from https://www.focusfishing.com/species/

Hinterland Who's Who. (n.d.). *Wildlife*. Retrieved June 27, 2021, from https://www.hww.ca/en/wildlife/

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International Rhino Foundation. (n.d.). *Rhino Species*. Retrieved June 27, 2021, from https://rhinos.org/about-rhinos/rhino-species/

Live Science. (n.d.). *Animals*. Retrieved June 27, 2021, from https://www.livescience.com/animals

Missouri Department of Conservation. (n.d.). *Field Guide*. Retrieved June 27, 2021, from https://mdc.mo.gov/discover-nature/field-guide

Montana's Official State Website. (n.d.). *Montana Field Guide*. Retrieved June 27, 2021, from http://fieldguide.mt.gov/default.aspx

National Geographic. (n.d.). *National Geographic*. Retrieved June 15, 2021, from https://www.nationalgeographic.com/

National Oceanic and Atmospheric Administration. (n.d.). *NOAA Fisheries*. Retrieved June 15, 2021, from https://www.fisheries.noaa.gov/

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Natural History Museum. (n.d.). *The life of the blue whale*. Retrieved June 27, 2021, from https://www.nhm.ac.uk/bluewhale/

Nord University. (n.d.). *BirdID's Bird Guide*. Retrieved June 27, 2021, from https://www.birdid.no/bird/eBook.php

NYS Dept. of Environmental Conservation. (n.d.). *Animals, Plants, Aquatic Life*. Retrieved June 27, 2021, from https://www.dec.ny.gov/23.html

Ontario Fishes. (n.d.). *Ontario Freshwater Fishes Life History Database*. Retrieved June 27, 2021, from https://www.ontariofishes.ca/fish_list.php

Parc Animalier d'Auvergne. (n.d.). *Discover our animals*. Retrieved June 27, 2021, from https://www.parcanimalierdauvergne.fr/en/discover-our-animals/

RSPB. (n.d.). *The RSPB Wildlife Charity: Nature Reserves & Wildlife Conservation*. Retrieved June 15, 2021, from https://www.rspb.org.uk/

Sacramento Fish & Wildlife Office. (n.d.). *Endangered Species Accounts*. Retrieved June 27, 2021, from https://www.fws.gov/sacramento/es_species/Accounts/

San Diego Management & Monitoring Program. (n.d.). *Species*. Retrieved June 27, 2021, from https://sdmmp.com/species.php

Sea Turtle Conservancy. (n.d.). *Information About Sea Turtles: Species of the World*. Retrieved June 27, 2021, from https://www.conserveturtles.org/information-sea-turtles-species-world/

SEE Turtles. (n.d.). *SEE Turtles*. Retrieved June 15, 2021, from https://www.seeturtles.org/

The CornellLab. (n.d.). *All About Birds*. Retrieved June 15, 2021, from https://www.allaboutbirds.org/news/

The Mammal Society. (n.d.). *UK Mammal List*. Retrieved June 27, 2021, from https://www.mammal.org.uk/species-hub/uk-mammal-list/

	The Monachus Guardian. (n.d.). *Monk Seal Fact Files*. Retrieved June 27, 2021, from https://www.monachus-guardian.org/index.php
	The Peregrine Fund. (n.d.). *Explore raptors page*. Retrieved June 27, 2021, from https://www.peregrinefund.org/explore-raptors-species
	Vulture Conservation Foundation. (n.d.). *Vultures*. Retrieved June 27, 2021, from https://www.4vultures.org/vultures/
	Washington Department of Fish & Wildlife. (n.d.). *Species & Habitats*. Retrieved June 27, 2021, from https://wdfw.wa.gov/species-habitats
	World Wildlife Fund. (n.d.). *Yangtze Finless Porpoise*. Retrieved June 27, 2021, from https://www.wwf.org.uk/sites/default/files/2018-01/WWF_WiW_2017_Factsheet_Yangtze Finless Porpoise FINAL.pdf
	WWF. (n.d.). *WWF - Endangered Species Conservation | World Wildlife Fund*. Retrieved June 15, 2021, from https://www.worldwildlife.org
Target population	
	Department for Communities and Local Government. (2010). *English Housing Survey*.
	Department of Census and Statistics. (2012). *Census of Population and Housing Sri Lanka*.
	P.E.I. Statistics Bureau - Department of Finance. (2018). *Province of Prince Edward Island forty-fourth annual statistical review 2017*. www.princeedwardisland.ca
	Statistics Sweden. (n.d.). *Summary of Population Statistics 1960–2020*. Retrieved June 27, 2021, from https://www.scb.se/en/finding-statistics/statistics-by-subject-area/population/population-composition/population-statistics/pong/tables-and-graphs/yearly-statistics--the-whole-country/summary-of-population-statistics/
	Telschow, D. (2002). *Population and Housing Sampler*. http://www.mnplan.state.mn.us/demography/
	U.S. Census Bureau. (n.d.). *QuickFacts: Vilas County, Wisconsin*. Retrieved June 27, 2021, from https://www.census.gov/quickfacts/geo/chart/vilascountywisconsin/HSD410219

Appendix II Studies included in the database

Table A.II The sources of the studies that were included in the database and the species that were valued in these studies

Reference	Species
Aldrich, G. A., Grimsrud, K. M., Thacher, J. A., & Kotchen, M. J. (2007). Relating environmental attitudes and contingent values: How robust are methods for identifying preference heterogeneity? *Environmental and Resource Economics*, *37*(4), 757–775. https://doi.org/10.1007/s10640-006-9054-7	Peregrine falcon; Shortnose sturgeon
Bandara, R., & Tisdell, C. (2004). The net benefit of saving the Asian elephant: A policy and contingent valuation study. *Ecological Economics*, *48*(1), 93–107. https://doi.org/10.1016/j.ecolecon.2003.01.001	Asian elephant
Bandara, R., & Tisdell, C. (2005). Changing abundance of elephants and willingness to pay for their conservation. Journal of Environmental Management, 76(1), 47–59. https://doi.org/10.1016/j.jenvman.2005.01.007	Asian elephant
Baral, N., Gautam, R., Timilsina, N., & Bhat, M. G. (2007). Conservation implications of contingent valuation of critically endangered white-rumped vulture Gyps bengalensis in South Asia. *International Journal of Biodiversity Science and Management*, *3*(3), 145–156. https://doi.org/10.1080/17451590709618169	White-rumped vulture
Bartczak, A., & Meyerhoff, J. (2013). Valuing the chances of survival of two distinct Eurasian lynx populations in Poland - Do people want to keep the doors open? In Journal of Environmental Management (Vol. 129, pp. 73–80). https://doi.org/10.1016/j.jenvman.2013.05.046	Eurasian lynx
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(4), 199–211. https://doi.org/10.1016/j.jnc.2009.04.004	Griffon vulture
Bednar-Friedl, B., Gebetsroither, B., & Getzner, M. (2009). Willingness to Pay for Species Conservation Programs: Implications for National Park Funding. Eco.Mont, 1(1), 9–14. https://doi.org/10.1553/eco.mont1s9	Rock partridge; Austrian ibex
Bell, K. P., Huppert, D., & Johnson, R. L. (2003). Willingness to pay for local coho salmon enhancement in coastal communities. Marine Resource Economics, 18(1), 15–31. https://doi.org/10.1086/mre.18.1.42629381	Coho salmon
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(2), 294–307. https://doi.org/10.2307/40986916	Silvery minnow
Boman, M., & Bostedt, G. (1999). Valuing the wolf in Sweden: Are benefits contingent upon the supply? In Topics in Environmental Economics (pp. 1–25). Springer. https://doi.org/https://doi.org/10.1007/978-94-017-3544-5_9	Grey wolf
Bosetti, V., & Pearce, D. (2003). A study of environmental conflict: The economic value of Grey Seals in southwest England. Biodiversity and Conservation, 12(12), 2361–2392. https://doi.org/10.1023/A:1025809800242	Grey seal
Bowker, J. M., & Stoll, J. R. (1988). Use of Dichotomous Choice Nonmarket Methods to Value the Whooping Crane Resource.	Whooping crane

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(1), 189–197. https://doi.org/10.1016/j.marpol.2011.05.003	Beluga whale; Harbour seal; Blue whale
Boyle, K. J., & Bishop, R. C. (1987). Valuing wildlife in benefit-cost analyses: A case study involving endangered species. Water Resources Research, 23(5), 943–950. https://doi.org/10.1029/WR023i005p00943	Striped shiner; Bald eagle
Broberg, T., & Brännlund, R. (2008). On the value of large predators in Sweden: A regional stratified contingent valuation analysis. Journal of Environmental Management, 88(4), 1066–1077. https://doi.org/10.1016/j.jenvman.2007.05.016	Wolverine; Brown bear; Grey wolf; Eurasian lynx
Cazabon-Mannette, M., Schuhmann, P. W., Hailey, A., & Horrocks, J. (2017). Estimates of the non-market value of sea turtles in Tobago using stated preference techniques. Journal of Environmental Management, 192, 281–291. https://doi.org/10.1016/j.jenvman.2017.01.072	Leatherback turtle
Cerda, C., & Losada, T. (2013). Assessing the value of species: A case study on the willingness to pay for species protection in Chile. Environmental Monitoring and Assessment, 185(12), 10479–10493. https://doi.org/10.1007/s10661-013-3346-5	Moon-toothed degu
Chambers, C. M., & Whitehead, J. C. (2003). A Contingent Valuation Estimate of the Benefits of Wolves in Minnesota. Environmental and Resource Economics, 26(2), 249–267. https://doi.org/10.1023/A:1026356020521	Grey wolf
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Clucas, B., Rabotyagov, S., & Marzluff, J. M. (2015). How much is that birdie in my backyard? A cross-continental economic valuation of native urban songbirds. Urban Ecosystems, 18(1), 251–266. https://doi.org/10.1007/s11252-014-0392-x	European greenfinch; American crow; European magpie; House finch
Cummings, R. G., Ganderton, P. T., & McGuckin, T. (1994). Substitution Effects in CVM Values. American Journal of Agricultural Economics, 76(2), 205–214. https://doi.org/10.2307/1243622	Colorado squawfish
Decker, K. A., & Watson, P. (2017). Estimating willingness to pay for a threatened species within a threatened ecosystem. Journal of Environmental Planning and Management, 60(8), 1347–1365. https://doi.org/10.1080/09640568.2016.1221797	Giant palouse earthworm
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(3), 253–262. https://doi.org/10.1111/conl.12065	Monarch butterfly
Dong, Y. (2013). Contingent valuation of Yangtze Finless porpoises in Poyang Lake, China. Contingent Valuation of Yangtze Finless Porpoises in Poyang Lake, China, September, 1–232. https://doi.org/10.1007/978-94-007-2765-6	Yangtze finless porpoise
Duffield, J. (1991). An economic analysis of wolf recovery in Yellowstone: park visitor attitudes and values. In J. Varley & W. Brewster (Eds.), Wolves for Yellowstone? (pp. 13–19). National Park Service: Yellowstone National Park.	Grey wolf

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Ericsson, G., Kindberg, J., & Bostedt, G. (2007). Willingness to pay (WTP) for wolverine Gulo gulo conservation. Wildlife Biology, 13(SUPPL. 2), 2–12. https://doi.org/10.2981/0909-6396(2007)13[2:wtpwfw]2.0.co;2	Wolverine
Fan, Z. (2008). Investigating the Potential for a PES (Payment for Environmental Services) System for Marine Turtle Conservation: The Case of Protection of Marine Turtle Breeding Sites in Crete, Greece. https://webapps.itc.utwente.nl/librarywww/papers_2008/msc/gem/zhangfan.pdf	Loggerhead turtle; Green turtle
Forbes, K., Boxall, P. C., Adamowicz, W. L., & Maio Sukic, A. De. (2015). Recovering Pacific rockfish at risk: The economic valuation of management actions. Frontiers in Marine Science, 2(SEP), 1–10. https://doi.org/10.3389/fmars.2015.00071	Pacific ocean perch
García-de la Fuente, L., Colina, A., Colubi, A., & González-Rodríguez, G. (2010). Valuation of environmental resources: The case of the brown bear in the North of Spain. Environmental Modeling and Assessment, 15(2), 81–91. https://doi.org/10.1007/s10666-009-9190-x	Cantabrian brown bear
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(3), 221–229. https://doi.org/10.1006/jema.1999.0277	Mexican spotted owl
Giraud, K., & Valcic, B. (2004). Willingness-to-pay estimates and geographic embedded samples: Case study of Alaskan Steller sea lion. Journal of International Wildlife Law and Policy, 7(1–2), 57–72. https://doi.org/10.1080/13880290490480167	Steller sea lion
Giraud, K., Turcin, B., Loomis, J., & Cooper, J. (2002). Economic benefit of the protection program for the Steller sea lion. Marine Policy, 26(6), 451–458. https://doi.org/10.1016/S0308-597X(02)00025-8	Steller sea lion
Haefele, M. A., Loomis, J. B., Lien, A. M., Dubovsky, J. A., Merideth, R. W., Bagstad, K. J., Huang, T. K., Mattsson, B. J., Semmens, D. J., Thogmartin, W. E., Wiederholt, R., Diffendorfer, J. E., & López-Hoffman, L. (2019). Multi-country Willingness to Pay for Transborder Migratory Species Conservation: A Case Study of Northern Pintails. Ecological Economics, 157(September 2018), 321–331. https://doi.org/10.1016/j.ecolecon.2018.11.024	Northern pintails
Hageman, R. (1985). Valuing marine mammal populations: Benefit valuations in a multi-species ecosystem. NOAA, NMFS, SWFSC Administrative Report LJ-85-22. 88p. 1985., 94.	Bottlenose dolphin; Grey whale; Blue whale; Northern elephant seal; Sea otter
Hamed, A., Madani, K., Von Holle, B., Wright, J., Milon, J. W., & Bossick, M. (2016). How Much Are Floridians Willing to Pay for Protecting Sea Turtles from Sea Level Rise? *Environmental Management*, *57*(1), 176–188. https://doi.org/10.1007/s00267-015-0590-1	Loggerhead turtle; Green turtle
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(5), 458–465. https://doi.org/10.1080/02827580802400562	Manchurian black bear

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(6), 534–543. https://doi.org/10.1080/02827581.2010.512874	Mountain goral
Hanley, N., Czajkowski, M., Hanley-Nickolls, R., & Redpath, S. (2010). Economic values of species management options in human-wildlife conflicts: Hen Harriers in Scotland. Ecological Economics, 70(1), 107–113. https://doi.org/10.1016/j.ecolecon.2010.08.009	Golden eagle; Hen harrier
Haqen, D. A., Vincent, J. W., & Welle, P. G. (1992). Benefits of Preserving Old-Growth Forests and the Spotted Owl. Contemporary Economic Policy, 10(2), 13–26. https://doi.org/10.1111/j.1465-7287.1992.tb00221.x	Spotted owl
Harder, D. S., Labao, R., & Santos, F. I. (2006). Saving the Philippine Eagle: How Much would It Cost and are Filipinos Willing to Pay for It ? Willingness to Pay for the Conservation of Endangered Species In Four Asian Countries, August, 77–119. http://www.eepsea.org/pub/book/128860061333_Willingness_to_Pay_Book.pdf	Phillipine eagle
Harper, D. L. (2012). Analyzing the Economic Benefit of Woodland Caribou Conservation in Alberta.	Woodland caribou
Heberlein, T. A., Wilson, M. A., Bishop, R. C., & Schaeffer, N. C. (2005). Rethinking the scope test as a criterion for validity in contingent valuation. Journal of Environmental Economics and Management, 50(1), 1–22. https://doi.org/10.1016/j.jeem.2004.09.005	Grey wolf
Hynes, S., & Hanley, N. (2009). The “Crex crex” lament: Estimating landowners willingness to pay for corncrake conservation on Irish farmland. Biological Conservation, 142(1), 180–188. https://doi.org/10.1016/j.biocon.2008.10.014	Corncrake
Indab, A. L. (2016). Willingness to Pay for Whale Shark Conservation in Sorsogon, Philippines. Marine and Coastal Ecosystem Valuation, Institutions, and Policy in Southeast Asia, April, 93–128. https://doi.org/10.1007/978-981-10-0141-3_6	Whale shark
Jakobsson, K. M., & Dragun, A. K. (2001). The worth of a possum: Valuing species with the contingent valuation method. Environmental and Resource Economics, 19(3), 211–227. https://doi.org/10.1023/A:1011128620388	Leadbeather's possum
Jin, J., He, R., Gong, H., & Wang, W. (2018). Role of risk preferences in explaining the public’s willingness to pay for marine turtle conservation in China. Ocean and Coastal Management, 160(April 2017), 52–57. https://doi.org/10.1016/j.ocecoaman.2018.04.006	Loggerhead turtle; Olive ridley turtle; Leatherback turtle; Hawksbill turtle; Green turtle
Jin, J., Indab, A., Nabangchang, O., Thuy, T. D., Harder, D., & Subade, R. F. (2010). Valuing marine turtle conservation: A cross-country study in Asian cities. Ecological Economics, 69(10), 2020–2026. https://doi.org/10.1016/j.ecolecon.2010.05.018	Loggerhead turtle; Olive ridley turtle; Leatherback turtle; Hawksbill turtle; Green turtle
Jin, J., Wang, Z., & Liu, X. (2008). Valuing black-faced spoonbill conservation in Macao: A policy and contingent valuation study. Ecological Economics, 68(1–2), 328–335. https://doi.org/10.1016/j.ecolecon.2008.03.014	Black-faced spoonbill
Kaffashi, S., Yacob, M. R., Clark, M. S., Radam, A., & Mamat, M. F. (2015). Exploring visitors’ willingness to pay to generate revenues for managing the National Elephant Conservation Center in Malaysia. Forest Policy and Economics, 56, 9–19. https://doi.org/10.1016/j.forpol.2015.03.004	Asian elephant

Kahneman, D., & Ritov, I. (1994). Determinants of stated willingness to pay for public goods: A study in the headline method. Journal of Risk and Uncertainty, 9(1), 5–37. https://doi.org/10.1007/BF01073401	Dolphins; African and Asian elephants; Peregrine falcon; Spotted owl; American elk; Florida panther; Black-footed ferret; Giant kangaroo rat
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. https://doi.org/10.1016/j.ecolecon.2012.04.008	Spotted seal
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. https://doi.org/10.1016/j.ecolecon.2012.04.023	Mediterranean monk seal
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(4), 483–499. https://doi.org/10.2307/3147295	Giant panda
Kotchen, M. J., & Reiling, S. D. (1998). Estimating and Questioning Economic Values for Endangered Species: An Application and Discussion. Endagered Species Update, 15(5).	Shortnose sturgeon; Peregrine falcon
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(1), 93–107. https://doi.org/10.1016/S0921-8009(99)00069-5	Shortnose sturgeon; Peregrine falcon
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 and Resource Economics, 12(4), 443–456. https://doi.org/10.1023/A:1008286001085	Mediterranean monk seal
Layton, D. F., Brown, G. M., & Plummer, M. L. (2001). Valuing multiple programs to improve fish populations.	Fish
Lee, D. E., & Du Preez, M. (2016). Determining visitor preferences for rhinoceros conservation management at private, ecotourism game reserves in the Eastern Cape Province, South Africa: A choice modeling experiment. Ecological Economics, 130, 106–116. https://doi.org/10.1016/j.ecolecon.2016.06.022	Black rhinoceros
Lew, D. K., Layton, D. 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(2), 133–154. https://doi.org/10.5950/0738-1360-25.2.133	Steller sea lion
Loomis, J. B. (1988). Benefits & Costs in Natural Resources Planning. In Western Regional Research Publication W-133 (Issue August).	Desert bighorn sheep
Loomis, J. B., & 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.	Grey whale
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(2), 356–366. https://doi.org/10.2307/40986954	Mexican spotted owl

Loomis, J., & Ekstrand, E. (1998). Alternative approaches for incorporating respondent uncertainty when estimating willingness to pay: The case of the Mexican spotted owl. Ecological Economics, 27(1), 29–41. https://doi.org/10.1016/S0921-8009(97)00126-2	Mexican spotted owl
Loureiro, M. L., & Ojea, E. (2008). Valuing local endangered species: The role of intra-species substitutes. Ecological Economics, 68(1–2), 362–369. https://doi.org/10.1016/j.ecolecon.2008.04.002	Common murre
Lundhede, T. H., Jacobsen, J. B., Hanley, N., Fjeldså, J., Rahbek, C., Strange, N., & Thorsen, B. J. (2014). Public support for conserving bird species runs counter to climate change impacts on their distributions. PLoS ONE, 9(7), 1–8. https://doi.org/10.1371/journal.pone.0101281	Golden plover; Great grey shrike; Goosander; Green sandpiper; Grey headed woodpecker; Ortolan bunting
Ma, K., Liu, D., Wei, R., Zhang, G., Xie, H., Huang, Y., Li, D., Zhang, H., & Xu, H. (2016). Giant panda reintroduction: factors affecting public support. Biodiversity and Conservation, 25(14), 2987–3004. https://doi.org/10.1007/s10531-016-1215-6	Giant panda
MacMillan, D., Hanley, N., & Daw, M. (2004). Costs and benefits of wild goose conservation in Scotland. Biological Conservation, 119(4), 475–485. https://doi.org/10.1016/j.biocon.2004.01.008	Wild goose
Martínez-Espiñeira, R. (2006). A Box-Cox Double-Hurdle model of wildlife valuation: The citizen's perspective. Ecological Economics, 58(1), 192–208. https://doi.org/10.1016/j.ecolecon.2005.07.006	Coyote
Martínez-Espiñeira, R. (2007). "Adopt a hypothetical pup": A count data approach to the valuation of wildlife. Environmental and Resource Economics, 37(2), 335–360. https://doi.org/10.1007/s10640-006-9051-x	Coyote
Morse-Jones, S., Bateman, I. J., Kontoleon, A., Ferrini, S., Burgess, N. D., & Turner, R. K. (2012). Stated preferences for tropical wildlife conservation amongst distant beneficiaries: Charisma, endemism, scope and substitution effects. Ecological Economics, 78, 9–18. https://doi.org/10.1016/j.ecolecon.2011.11.002	Gorilla; Lion; Frog; Toad; Lizard; Bird
Nabangchang, O. (2008). Private Contributions Towards the Provision of Public Goods: The Conservation of Thailand's Endangered Species. In EEPSEA Research Report.	Asian elephant; Dugong; Gibbon; Hornbill; Marine turtles; Indochinese tiger;
Neupane, D., Kunwar, S., Bohara, A. K., Risch, T. S., & Johnson, R. L. (2017). Willingness to pay for mitigating human-elephant conflict by residents of Nepal. Journal for Nature Conservation, 36, 65–76. https://doi.org/10.1016/j.jnc.2017.02.004	Asian elephant
Ngouhouo Poufoun, J., Abildtrup, J., Sonwa, D. J., & Delacote, P. (2016). The value of endangered forest elephants to local communities in a transboundary conservation landscape. Ecological Economics, 126(March 1973), 70–86. https://doi.org/10.1016/j.ecolecon.2016.04.004	African forest elephant
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(1), 61–72. https://doi.org/10.1016/j.ecolecon.2004.10.005	Asian elephant
Ojea, E., & Loureiro, M. L. (2007). Altruistic, egoistic and biospheric values in willingness to pay (WTP) for wildlife. Ecological Economics, 63(4), 807–814. https://doi.org/10.1016/j.ecolecon.2007.02.003	Common murre

Rathnayake, R. M. W. (2016). "Turtle watching": A strategy for endangered marine turtle conservation through community participation in Sri Lanka. Ocean and Coastal Management, 119, 199–207. https://doi.org/10.1016/j.ocecoaman.2015.10.014	Loggerhead turtle; Green turtle; Leatherback turtle; Hawksbill turtle; Olive ridley turtle
Reaves, D. W., Kramer, R. A., & Holmes, T. P. (1999). Does question format matter? Valuing an endangered species. Environmental and Resource Economics, 14(3), 365–383. https://doi.org/10.1023/A:1008320621720	Red-cockaded woodpecker
Ressurreição, A., Gibbons, J., Dentinho, T. P., Kaiser, M., Santos, R. S., & Edwards-Jones, G. (2011). Economic valuation of species loss in the open sea. Ecological Economics, 70(4), 729–739. https://doi.org/10.1016/j.ecolecon.2010.11.009	Fish; Inverts; Marine mammal; All marine species; Sea birds
Rubin, J., Helfand, G., & Loomis, J. (1991). A Benefit-Cost Analysis of the Northern Spotted Owl.	No. Spotted owl
Rudd, M. A. (2009). National values for regional aquatic species at risk in Canada. Endangered Species Research, 6(3), 239–249. https://doi.org/10.3354/esr00160	White sturgeon; Atlantic salmon; North atlantic right whale; Leatherback turtle; Atlantic white fish
Rudd, M. A., Andres, S., & Kilfoil, M. (2016). Non-use Economic Values for Little-Known Aquatic Species at Risk: Comparing Choice Experiment Results from Surveys Focused on Species, Guilds, and Ecosystems. Environmental Management, 58(3), 476–490. https://doi.org/10.1007/s00267-016-0716-0	Channel darter; Lake sturgeon; Pugnose shiner
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(1–2), 101–115. https://doi.org/10.1016/j.ecolecon.2004.03.025	Florida manatee
Stanley, D. L. (2005). Local perception of public goods: Recent assessments of willingness-to-pay for endangered species. Contemporary Economic Policy, 23(2), 165–179. https://doi.org/10.1093/cep/byi013	Riverside fairy shrimp
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(4), 390–400.	Bald eagle; Coyote; Atlantic salmon
Stevens, T. H., Glass, R., More, T., & Echeverria, J. (1991). Wildlife recovery: is benefit-cost analysis appropriate? Journal of Environmental Management, 33(4), 327–334. https://doi.org/10.1016/S0301-4797(05)80021-0	Bald eagle; Wild turkey
Stithou, M. (2009). Respondent Certainty and Payment Vehicle Effect in Contingent Valuation: an Empirical Study for the Conservation of Two Endangered Species in Zakynthos Island.	Mediterranean monk seal; Loggerhead turtle
Swanson, C. S. (1993). Economics of non-game management: bald eagles on the skagit river bald eagle natural area, washington. The Ohio State University.	Bald eagle
Swanson, T., Mourato, S., Swierzbinski, J., & Kontoleon, A. (1998). Conflicts in wildlife conservation: Aggregating total economic values. https://doi.org/10.4337/9781845424657.00014	Black rhinoceros
Tanguay, M. R., Adamowicz, W. L., & Boxall, P. C. (1995). An economic evaluation of woodland caribou in northwestern Saskatchewan.	Woodland caribou
Teh, L. S. L., Teh, L. C. L., & Jolis, G. (2018). An economic approach to marine megafauna conservation in the coral triangle: Marine turtles in Sabah, Malaysia. Marine Policy, 89(July 2017), 1–10. https://doi.org/10.1016/j.marpol.2017.12.004	Hawksbill turtle; Green turtle; Olive ridley turtle; Leatherback turtle

Thuy, T. D. (n.d.). WTP for Conservation of Vietnamese Rhino.	Javan rhinoceros
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(4), 1261–1281. https://doi.org/10.1007/s10531-006-6735-z	Koala; Northern hairy-nosed wombat
Tisdell, C., & Wilson, C. (2001). Wildlife-based tourism and increased support for nature conservation financially and otherwise: Evidence from sea turtle ecotourism at Mon Repos. Tourism Economics, 7(3), 233–250. https://doi.org/10.5367/000000001101297847	Loggerhead turtle; Flatback turtle; Green turtle; Leatherback turtle
Tisdell, C., Nantha, H. S., & Wilson, C. (2005). Public Valuation of and Attitudes towards the Conservation and Use of the Hawksbill Turtle: An Australian Case Study.	Golden-shouldered parrot; Tree-kangaroo; Hawksbill turtle
Tisdell, C., Wilson, C., & Nantha, H. S. (2005). Policies for saving a rare Australian glider: Economics and ecology. Biological Conservation, 123(2), 237–248. https://doi.org/10.1016/j.biocon.2004.11.012	Mahogany glider
Tseng, W. C., & Chen, C. C. (2008). Valuing the potential economic impact of climate change on the Taiwan trout. Ecological Economics, 65(2), 282–291. https://doi.org/10.1016/j.ecolecon.2007.06.015	Taiwan trout
Veisten, K., Fredrik Hoen, H., Navrud, S., & Strand, J. (2004). Scope insensitivity in contingent valuation of complex environmental amenities. Journal of Environmental Management, 73(4), 317–331. https://doi.org/10.1016/j.jenvman.2004.07.008	White-backed woodpecker
Vredin, M. (1996). Valuing a Peripheral Environmental Amenity. The Swedes' Willingness to Pay for the Survival of the African Elephant.	African elephant
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(7), 1793–1801. https://doi.org/10.1016/j.jenvman.2011.02.012	Puget sound chinook salmon; Smalltooth sawfish; Hawaiian monk seal
Wallmo, K., & Lew, D. K. (2012). Public Willingness to Pay for Recovering and Downlisting Threatened and Endangered Marine Species. Conservation Biology, 26(5), 830–839. https://doi.org/10.1111/j.1523-1739.2012.01899.x	Puget sound chinook salmon; Smalltooth sawfish; Upper willamette river chinook salmon; Hawaiian monk seal; North Atlantic right whale; North pacific right whale; Leatherback turtle; Loggerhead turtle
Wallmo, K., & Lew, D. K. (2016). A comparison of regional and national values for recovering threatened and endangered marine species in the United States. Journal of Environmental Management, 179, 38–46. https://doi.org/10.1016/j.jenvman.2016.04.053	Coho salmon; Southern California steelhead; Black abalone; Humpback whale; Killer whale; Hawksbill turtle
Wang, Z., Gong, Y., & Mao, X. (2018). Exploring the value of overseas biodiversity to Chinese netizens based on willingness to pay for the African elephants' protection. Science of the Total Environment, 637–638(19), 600–608. https://doi.org/10.1016/j.scitotenv.2018.04.417	African elephant

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(3), 345–354. https://doi.org/10.1016/S0006-3207(97)00036-0	European water vole; Otter
Whitehead, J. C. (1992). Ex ante willingness to pay with supply and demand uncertainty: Implications for valuing a sea turtle protection programme. Applied Economics, 24(9), 981–988. https://doi.org/10.1080/00036849200000075	Loggerhead turtle
Wilson, C., & Tisdell, C. (2003). Conservation and economic benefits of wildlife-based marine tourism: Sea turtles and whales as case studies. Human Dimensions of Wildlife, 8(1), 49–58. https://doi.org/10.1080/10871200390180145	Humpback whale
Zander, K. K., Ainsworth, G. B., Meyerhoff, J., & Garnett, S. T. (2014). Threatened bird valuation in Australia. PLoS ONE, 9(6). https://doi.org/10.1371/journal.pone.0100411	Australian birds
Zander, K. K., Pang, S. T., Jinam, C., Tuen, A. A., & Garnett, S. T. (2014). Wild and valuable? Tourist values for orang-utan conservation in Sarawak. Conservation and Society, 12(1), 27–42. https://doi.org/10.4103/0972-4923.132126	Bornean orangutan
Zander, K. K., Signorello, G., De Salvo, M., Gandini, G., & Drucker, A. G. (2013). Assessing the total economic value of threatened livestock breeds in Italy: Implications for conservation policy. Ecological Economics, 93, 219–229. https://doi.org/10.1016/j.ecolecon.2013.06.002	Maremmana cattle; Modicana cattle breed