Measuring the non-use value of the Dugong (Dugong dugon) in Thailand

Areeyapat Petcharat and Yohan Lee

Yeungnam University, Republic of Korea

Contributed paper prepared for presentation at the 64th AARES Annual Conference, Perth, Western Australia 12-14 February 2020.

Measuring the non-use value of the Dugong (*Dugong dugon*) in Thailand

Areeyapat Petcharat, Yohan Lee

Department of Forest Resources and Landscape Architecture, Yeungnam University, Korea Rep.

Abstract

The dugong is an herbivorous marine mammal species, being vulnerable to extinction throughout its range in the Indo-Pacific region. This paper used the choice experiment method to elicit the non-use value, or the non-users' willingness to pay (WTP) for conserving the dugongs in Thailand. A face-to-face interview was used to obtain data from 300 residents in five selected districts of Bangkok. The results show that the average WTP for the most preferred dugong conservation scheme (a marker buoy system, recreating habitats, and slowing down the population decline) was 4,382 Thai Baht (USD122) annually per household. Significantly, developing the marker buoy system to identify dugong habitats was the most valued by the general public. However, the respondents were not willing to pay for educating local fishers about the conservation of dugongs. Our results implies that a conservation policy should concentrate on the participation of key fishers in dugong protection projects using incentive measures. We also suggest the government to create protected areas as dugong sanctuaries that consistently support the remaining dugong population.

Keywords: Choice experiments, Non-use values, Willingness to pay, the Dugong (*Dugong dugon*)

Introduction

The dugong (*Dugong dugon*) is an endangered marine mammal species, listed as vulnerable to extinction at a global scale (Marsh et al 1999). However, local government or the public often neglects the value of dugong protection in decision-making processes. Due to a missing market in the real world for natural assets, unfortunately the benefits from conserving this species cannot be directly measured in monetary terms.

Environmental economists believe that the monetary term of non-use values is critical information to orient policy formulation in a number of ways. First, it is essential to have common units of comparison for comparing benefits and costs when choosing optimal policy options. For instance, the costs of dugong protection measures have to be compared with the total benefit for the existence of the species. This principle is called cost-benefit analysis, which was first used in the U.S. in the early twentieth century to evaluate water development projects (Field and Field 2009). Second, economic valuation allows policymakers to quantify the environmental impact in monetary terms (Tisdell 2005). In addition, environmental values have a role to play in raising environmental awareness by showing the importance of the environment and natural resources. For example, the value of wildlife can be used as evidence for limiting or banning trade in an endangered species (Christie et al 2004). Therefore, economists have developed two branches of methods for non-market valuation: the revealed preference and stated preference approaches.

The revealed preference approach is grounded in actual behavior and is, thus not suitable for measuring non-use values, i.e. the values that not related to usages such as existence values and bequest values, while the stated preference approach is capable of estimating both use and non-use values (Hanley and Spash 1993; Tunstall and Coker 1996). Therefore, the stated preference approach that relies on the stated preferences or stated values by individuals and assesses values directly through survey methods is widely used. Two key methods under the stated preference approach are the contingent valuation method and choice experiments (Tisdell 2005). The former method is used to estimate the total change in an environmental good, while the latter method is capable of valuing environmental changes that are multidimensional (Pearce et al 2006).

The choice experiment method involves creating a hypothetical market situation and elicits individuals' preferences for the attributes by asking them to make a choice between certain alternatives. In other words, the choice experiment tries to mimic an existing market for a non-market good, which is described by a set of attributes. The choice experiment is consistent with the Lancasterian microeconomic approach, assuming that individuals obtain utility or well-being from a good based on the characteristics or attributes of the good, rather than directly from the good per se (Campbell et al 2008). For example, some people may derive much more enjoyment from a fishing trip if it is on a relatively pristine river with few other fishers around, while others may prefer fishing on a lake with other fishers present (Wallmo 2003). Thus, choice experiments try to give people enough choices to cover the full spectrum of opportunities that are available by mixing and matching all of the different options so that people will have a wide variety of choices between which they can be chosen.

Knowing which choice people make from a bundle of options researchers can observe the sources of tradeoffs they are willing to make. They may substitute one of these characteristics from another so that the marginal rate of substitution between these characteristics can be inferred. Because it consists of a cost as one of these characteristics of the good or product, a marginal rate of substitution between these characteristics and money can be estimated. It also presents the price that people are willing to pay to obtain more of each attribute that describes the products. This approach provides a tool to estimate the value that people hold for improvement in a good's attributes or the amount of money to avoid an adverse attribute in a product that they do not appreciate (Adamowicz et al 1998). Moreover, by knowing which attributes in the components are valued by which segments of the population, it is possible to design policies or projects that are more targeted and generate the overall highest benefit (Hanley et al 1998).

In Thailand, the information related to the monetary benefits of threatened species is limited while it is needed for the government to prepare and deliver policies based on accurate information. Thus the objective of this study is to elicit people's preferences and the non-use values relating to dugong preservation. The non-users' willingness to pay (WTP) for changes in the ecological and social conditions of the dugongs and their habitats are estimated using the choice experiment method. We expect to provide practical information for policymakers to consider the importance of dugong preservation in decision-making processes and to design optimal dugong conservation strategies in Thailand.

This paper is organized as follows. The next sector introduces the case study of the dugong (*Dugong dugon*) in Thailand and the study methods employed, especially the choice experiment survey and the model specification. This is followed by results, and then conclusions and discussion.

Methods

Case study: the dugong (Dugong dugon)

The dugong (*Dugong dugon*) is the only extant herbivorous marine mammal in the family Dugongidae, order Sirenia. This species is a long-lived animal with a low reproductive rate, long generation time, and a high investment in each offspring (Marsh et al 1999). Dugongs live as long as 70 years, reach up to 3 m in length. As the dugongs are air-breathing herbivores, they usually stay underwater for less than 10 minutes before surfacing. The two nostrils on the end of their snouts allow the dugongs to breathe without presenting the whole body above the water. The dugongs feed on seagrasses but occasionally consume marine algae and invertebrate animals when seagrasses are rare (Marsh 2017). Naturally, they tend to feed in a group and produce feeding trails by digging up the sediment with their mouth and removing seagrasses. The trails range from 19 to 25 cm wide, 1 to 5 m long, and 3-5 cm in depth. The amount of food this species consumes in nature is not known, however, a couple of dugongs in captivity ate 50-55 kg of seagrass (wet weight) per day. The dugongs are both migratory and resident species. Some dugongs remain in a given area while other animals migrate seasonally to warmer waters (Heinsohn et al 1977). This species has a large range covering more than forty countries including tropical and subtropical coastal and waters from East Africa to Vanuatu (Marsh et al 1999). Historically the distribution of the dugong is known from anecdotal reports from fishers or incidental sightings. Recently, especially in Australia, aerial surveys have been conducted extensively in order to gain comprehensive information (Marsh 2017). The dugongs are rare or in danger of extinction over most of the species' range. Although the largest population occurs in Australia, the other populations in the eastern hemisphere are fragmented. The dugongs were reported along both coastlines of Thailand, the Gulf of Thailand and the Andaman Sea. Presently the largest group of dugongs has been found in Trang province particularly in Muk and Talibong Islands (Figure 1) (UNEP 2001). According to the aerial surveys conducted along the Andaman coast in 2000 and 2001, the number of 123 individuals was estimated to exist among the seagrass beds southeast of Talibong Island (Hines et al 2005).

Insert Figure 1 here

The dugong has been legally protected under the Thai Fisheries Act since 1947. The dugong is one of the fifteen designated reserved animal species, which are defined by the Wild Animal Reservation and Protection Act of BE 2535 (1992). However, the number of dugongs in Thailand is rapidly decreasing. Although most dugongs died by unidentified cause, the highest proportion of deaths was incidentally entangled in fishing gears (Adulyanukosol et al 2009). Habitat loss resulting from shrimp farms was a serious problem for the dugong population in the Gulf of Thailand. Whereas dugongs in the Andaman Sea are vulnerable because of habitat destruction and degradation due to which are resulting from fishing practices, water pollution, and sediment. The dugongs have also been hunted for their skin, bones, tears, and tusks, and sole to an amulet-maker. Additionally, an increase in tourism activities, especially the number of boats in Trang, Krabi, Phuket, and Satun provinces, has created negative impacts on seagrass beds, which are dugongs' main food sources and increased the risk of boat strikes on dugongs (UNEP 2001).

Choice experiment study

This study used a choice experiment method to extract respondents' preferences and WTP for various attributes of hypothetical dugong conservation schemes. The choice experiment design was carried out to identify attributes and attribute levels, and design choice sets. Identification of relevant attributes of the dugong conservation schemes to be valued is the most important step of the choice experiment study. It is essential to include all attributes that matter or else the policy will have to change (Adamowicz et al 1998). Four key attributes used in this study were selected on the basis of the objectives of the research, prior beliefs, and evidence from literature reviews and consultations with experts or conservationists in dugong conservation fields. These attributes include a dugong population, a dugong habitat, an awareness campaign, and a buoy system. Then, as Alberini and Longo (2006) suggest that qualitative attributes should be described in two or three levels, including the present situation (status quo) and some policy changes in one or both directions, this allows the researcher to estimate the welfare change from the status quo. Therefore, the first attribute, the dugong population has 3 possible levels of impact on dugong population (level 1 correspondents to status quo which is continued decline in dugong population, level 2 is slow down the decline in the dugong population, and level 3 represents a recovery of dugong population). The second attribute, the dugong habitat consisted of 3 levels (level 1 is degradation resulting from no action, level 2 represents restoration by better management of existing habitats, and level 3 is recreation new habitats for dugongs. The third attribute is the knowledge of fishers, which comprises of two levels (level 1 is some local fishers are educated about the conservation of dugongs and level 2 is a lot of local fishers are educated). Lastly, the marker buoy system attribute involved two levels (level 1 is no buoy and level 2 is provided marker buoys). The attributes and attribute levels are shown in Table 1. Importantly, in order to calculate welfare measures, a monetary attribute needs to be included. Thus, an annual financial contribution per household to promote dugong conservation was also added to each conservation scheme for obtaining an effective scheme. The monetary attribute levels used were 100, 200, 500, and 1,000 Thai Baht.

Insert Table 1 here

To combining the levels of the attributes into different scenarios or choice sets, a statistical design theory was used. Thus, the choice experimental design was developed using an efficient Bayesian design to combine the levels of the attributes into a number of alternative scenarios to be offered to respondents. The attributes and attribute levels presented in Table 1 result in $2^2 \times 3^2 \times 5$ (i.e., 180) possible hypothetical scenarios. As this number is large and it is impossible to include all scenarios in the questionnaire, a Bayesian design was used to reduce the number of scenario combinations. The profiles of choice tasks were generated using the experimental design software, Ngene. Each choice set consisted of two possible outcomes – labeled as ‘Option A’ and ‘Option B’. Each option described the conservation status of the dugong and dugong habitat after implementation of the specific hypothetical conservation scheme. An example of a translated choice set for the dugong is shown in Figure 2.

Insert Figure 2 here

Before distributing the final survey, a 45-pilot test of the survey instrument was carried out to confirm the appropriateness of the selected attributes and the choice set design. Consequently, the final questionnaire or interview script (see Appendix for the translated interviewer's scripted) comprises of three sections. The first section consisted of questions related to respondents' perceived changes in the environment and their perceived threats to dugongs in Thailand, including the perception of required management to conserve this species. The second section involved the choice sets, in this part; the respondent was faced with eight choice sets. Typically, respondents were asked to choose their most preferred scenario from each choice set. The last section gathered demographic data for statistical analysis of the survey responses.

Data collection

When the questionnaire is finalized, the choice experiment survey can be administered to collect data. A stratified random sample was adopted as a sampling method. The population of interest was the adult (18-year-old and over) residents in Bangkok, the capital city of Thailand. Five of the 50 districts of Bangkok were randomly selected as the survey sites. These included Chatuchak, Bang Khae, Pathum Wan, Dusit and Bang Kapi districts. As a face-to-face interview was used as a technique to collect data, the survey was administered between June and July 2015. A final sample of 300 face-to-face interviews was conducted in several sites such as parks, universities and shopping malls located in five districts of Bangkok. The survey sites included: Chatuchak Park and Kasetsart University in Chatuchak District; The Mall Shopping Centre in Bang Khae District; Siam Paragon shopping center and Chulalongkorn University in Pathum Wan District; Dusit Zoo in Dusit District and Ramkhamhaeng University in Bang Kapi District. The average length of an interview was approximately 30 to 45 minutes. According to the choice experiment section, each respondent answered eight choice tasks, resulting in 8×300 (2400) observations for the dugong model estimation. At the final step, statistical analyses are used to obtain the marginal value of these attributes and the WTP for an alternative of interest (Alberini and Longo 2006).

Model specification

In the choice experiment method, Random Utility Theory (RUT), a logic model and Lancaster's characteristics theory of value form the basis for model estimation (Adamowicz et al 1998). The RUT assumes that an individual will choose the alternative, which provides the greatest level of utility, and the respondent's utility (U) for an environmental good consists of two features: a systematic or known component ($\beta' X_{nj}$) and a random component (ε_{nj}). The utility that individual *n* receives from a given alternative *j* can be expressed as

$$U_{nj} = \beta' X_{nj} + \varepsilon_{nj} \qquad (1)$$

where β is a vector of the variables' parameters. As an individual will choose the alternative *j* which yields the greatest level of utility, the probability of choosing alternative *j* is equal to the probability that the utility of alternative *j* is greater than the utility associated with alternative *k* after evaluation each and every alternative.

In a choice experiment model the random part is assumed to be independently and identically distributed (IID). The probability of a chosen choice *j* from a choice set consisting of *m* is,

$$\Pr\{j \text{ is selected}\} = \frac{\exp(\beta'_j X_{nj})}{\sum_{m=1}^{J} \exp(\beta'_m X_{nm})} \qquad (2)$$

The conditional logit (CL) model assumes the independence of irrelevant alternatives (IIA) property, which states that the relative probabilities of two options being chosen are unaffected by the introduction or removal of other alternatives.

The maximal WTP for option *j*, is defined as the payment that makes an individual indifferent between the choice *j* and status quo choice *k*. Thus, a marginal WTP (MWTP) value of a change within a single attribute m can be represented as a ratio of coefficients as follows,

$$MWTP_m = - \beta_m / \beta_c \qquad (3)$$

where β_m is the coefficient of attribute m and β_c is the coefficient of the monetary attribute. This part-worth formula provides effectively the marginal rate of substitution between cost change and the attribute in question (Bennett and Blamey 2001).

Finally, a relative difference of WTP (Δ WTP) associated with all changes in implementing the conservation scheme between two choice profiles is,

$$\Delta\, WTP_{jk} = -[(\sum \beta_m (X_{mj} / X_{mk}))/\beta_c] \qquad (4)$$

(Δ WT) quantified the variation in scheme outcomes in money terms as represented by two different choices which are used to elicit preferences for different scenarios relevant for management option.

Results

Characteristics of respondents

A total of 300 useable face-to-face interviews were obtained. It shows that over half of the respondents (54%) were female. A significant proportion of respondents were between the ages of 25-34. The age of the respondents ranged from 18 to 72 years, with a mean being 32 years. Moreover, forty-eight percent of respondents were single, while 45 percent were married. In addition, almost half of participants (45%) held bachelor degrees, while a quarter (23%) had completed secondary school level. The occupations of respondents were employees, self-employed and civil servants (35.3%, 25%, and 20.7% respectively). An additional 50 participants (a further 16 percent) were students. Approximately two third of the respondents had 4 to 6 members in their household. The total number of members per household ranged from 1 to 8. The majority of respondents had a low-level income, between 5,000 and 10,000 Baht/month (US$ 150-300). The reported household income level was median with 22.7 percent of respondents reporting between 20,000-25,000 Baht/month. The average household income was 20,085 Baht per household per month or 241,020 Baht per year. In addition, the majority of respondents were not members of an environmental group (87.7%).

Attitudes towards environmental problems and dugong conservation

Prior to the choice experiment questions being presented, respondents were asked a series of attitudinal questions using ranking scales. The respondents were first asked about the extent to which they felt the quality of each environmental component in Thailand. We asked whether the quality of the environment in Thailand has improved, remained stable or worsened in their lifetime. The overall majority of the respondents (85 %) stated that it has worsened while seven percent felt it has improved. Only three percent thought it has remained stable, however, five percent stated they did not know. While the component stated to have declined most was the forest area, indicated by 95 percent of respondents. Interestingly, eighthly two percent considered that marine animal abundance has worsened. The overall picture of perceived changes in Thailand’s environment is shown in Figure 3.

Insert Figure 3 here

Participants were also asked to rank the top three threats to dugongs in Thailand. As shown in Table 2, the most important threat perceived by the participants in Bangkok was onshore fishing, especially trawling in near-shore areas. The loss/degradation of dugong habitats was the second most important threat. On the other hand, coastal development was viewed as less dangerous than other issues.

Insert Table 2 here

Respondents were asked the question: What would you do if you were the governor to preserve the dugong in Thailand? When ranking their priority from first, second, and third most important methods, the results, as seen in Table 3, can be linked to the key perceived threats to the dugong, i.e. inshore fishing, accidental catch, and the loss and degradation of dugong habitats. The result was that almost half of the respondents (45.4%) required the prohibition of trawling in the near-shore areas in particular where dugong habitats are prohibited. It was followed by increasing penalties for violators of the laws (36.7%), implementing buoy systems to present dugong habitats (33%), expanding marine protected areas (32.7%), and increasing local fishers and public awareness on the dugong (30.7%) respectively. Conducting dugong research and monitoring ranks the last.

Insert Table 3 here

Conditional Logit Model and WTP estimates

The Conditional Logit Model was estimated using NLOGIT 4.0 (LIMDEP 9.0) Software. Parameter estimates for the model are presented in Table 4. These results show that the signs of the utility coefficients are consistent with expectation. The estimate for the price attribute is significant and negative. All of the parameters for the attributes are statistically significant and positive except the coefficient of awareness raising attribute that is negative. These findings mean that the dugong conservation schemes that provide a buoy system, improve the dugong habitat, and slow down the decline dugongs were more likely to be chosen. While, they were unlikely to choose the schemes that aim to increase the number of local fishers who are educated about the dugongs.

Insert Table 4 here

The choice experiment results were used to compute indirect WTP according to different levels of dugong population improvement. Presented in Table 5 are the average WTP estimates per household per year for improvements in each of the dugong attributes. These are the MWTP on average of moving from one level to an upper level. As can be seen from Table 5, the average WTP to enhance dugong populations from continued decline to slow down the decline was found to be 748 Baht per household per year. The value for an improvement from the slow down the decline to recovery was almost 500 Baht. For the second attribute, the dugong habitats, the average WTP to the change of dugong habitats from habitat degradation to habitat restoration was 1,150 Baht, and the average WTP for improving from habitat restoration to habitat recreation was almost 1,267 Baht. Whereas the respondents were unlikely to pay for enhancing awareness raising campaign for educating local fishers about dugong conservation from the status quo to the upper level, the average WTP was negative 1,607 Baht. Lastly, the average WTP for implementing marker buoy systems, which can be used to identify the areas where harmful fishing gears and high-speed boats are prohibited, was the highest value of almost 2,368 Baht. The overall average WTP to improve all of the mentioned attributes from the status quo to the most suitable dugong conservation scheme, which is that the dugong population improves from continued decline to slow down the decline, the habitat improves from degradation to re-creation, some fishers are educated and marker buoy systems are provided, was 748.19+1266.48+2367.71 (i.e., 4,382.38) Baht or USD122 per household per year.

Insert Table 5 here

Discussion

A number of issues can be drawn from the findings. Firstly, the coefficient of price has significant negative value and dugong population, dugong habitat, and buoy systems attributes had significant positive coefficients. This finding is consistent with other choice experiment studies, especially of Adamowicz et al (1998) measuring the passive use values relating to caribou preservation and founding the coefficient on the price has significantly negative value while the coefficients on caribou population and wilderness area attributes have significantly positive coefficients while. Secondly, the average WTP for slow down the declining level of the dugong population attribute was found to be higher than for the recovery level with 748 and 493 Baht respectively. Therefore, the people preferred to support a dugong conservation scheme that simply ensures dugong survival rather than recovering the dugong population. This finding likely reflects the fact that it is too difficult to recover the dugong population in Thailand. UNEP (2001) also stated the even with low natural mortality and no human-induced mortality a dugong population is unlikely to increase at more than about 5% percent per year. Thirdly, the dugong habitat, the average WTP for habitat recreation attribute was higher than habitat restoration attribute at 1,267 and 1,150 Baht respectively. This finding was in accordance with the choice experiment study reported by Christies et al (2004). They reported that the residents in Cambridgeshire were willing to pay a higher implicit price for habitat recreation than for habitat restoration at £61.36 and £34.40 respectively. Interestingly, the dugong improvement that was most valued by the general public related to the implementation of marker buoys, which amounted to approximately 2,368 Baht/household/year. It possibly related to results from attitudinal questions. Inshore fishing, especially trawling in near-shore areas, and degradation of habitats was perceived as the main threats to the dugong in Thailand. These may be the reasons why the respondents were willing to place a high value on an environmental scheme with its aim to reduce these risks, especially providing buoy systems. Fourthly, the finding was surprisingly interesting since awareness raising attribute was significant in the model but the average WTP for increasing the number of awareness campaigns for local fishers was found to be negative (-1,607 Baht). This meant that the respondents preferred the status quo to increase the number of local fishers who are educated about dugong conservation. According to this result, there are two supported reasons. First, as presented in Table 3, whilst respondents perceived that increasing the number of well-educated fishers was less important than prohibiting trawling, increasing penalties, implementing marker buoy systems, and expanding marine protected areas. Second, the marine Education Support Centers, NGOs such as Yadfon Association and Wildlife Fund Thailand have been working together in developing a number of education and information programs on dugongs (UNEP 2001). Thus, respondents may consider that educational activities on dugong conservation for local fishers in Thailand have been improved greatly in recent years so that they prefer the status quo to the increased level. Finally, although people's opinion on the WTP for dugong conservation was less than 1 % of the average annual household incomes (241,020 Baht), the overall average WTP for the most preferred dugong conservation scheme was about 4,382 Baht (USD122) per year. This value was as high as 2 % of the respondents' annual incomes.

Conclusions and policy implicaitions

The purpose of this study is to determine people preferences and the non-use value of the dugong conservation in Thailand. By applying the choice experiment framework, therefore, the value that non-users willing to pay for a range of enhancements to dugong populations and their habitats in the country was elicited. Moreover, people's attitudes toward the state of the nation's environment and dugongs were obtained during the experimental survey. The analysis of the experiments to assess the respondent's preferences for dugong conservation goals returned key findings. Initially, the overall average WTP for the most preferable choice of the dugong conservation scheme would be to slow down the dugong population decline, the required habitats would need to be recreated, and buoy systems provided; the cost of this would require almost 4,382 Baht (USD122) annually per household. The dugong improvement most valued by the general public related to the implementation of a marker buoy system. The WTP for implementing buoys was almost 2,370 Baht (USD70.5) per household per year. The following were habitat recreation (1,267 Baht), habitat restoration (1150 Baht), and slowing down the decline of dugong population (748 Baht). However, the respondents were not willing to pay to increase the number of programs for improving local fishers' knowledge and awareness of dugong conservation.

This study provides information for policy implications on dugong and coastal ecosystem management and highlights a number of issues that related organizations need to consider with respect to the interpretation of choice experiment results. First, it is concluded that the respondent's most preferred choice within the scheme was to provide marker buoys for indicating dugong habitats so that inappropriate fishing activities and high-speed boating are prohibited. Second, it is important to recreate and maintain high-quality dugong habitats. This is due to the fact that the dugong's fecundity relies on the availability of seagrasses. If they do not have enough food and nutrients the breeding process may be delayed and direct impact on the survival of dugongs (Marsh 2017). We recommend that legislation enlarging their habitats as dugong sanctuaries and addressing threatened sergrass ecosystems be enacted and strengthened. The third crucial issue is to slow down the dugong population decline. Marsh (2017) points out that the dugong has a low reproductive rate and the rate of change of a dugong population depends on the survival of the adults. Therefore, reducing the adults' mortality rate, especially by entanglement in fishing gear, is one of the critical issues in dugong conservation. Therefore, instead of increasing the number of local fishers who are educated about dugong conservation, the government should provide incentives for encouraging key fishers to participate in community-based dugong conservation projects. For example, the participated fishers would be required to release live dugongs caught in nets, to record dugong sightings, and to report illegal near shore fishing practices. Thus participating in the dugong conservation project could also increase the fishers' incomes. It is important to note that this study only provided non-use values, which are only one part of the total economic value. In a cost-benefit analysis for environmental resources, it is important to elicit the other types of values such as the use and option values. Thus, further studies using other appropriate valuation techniques are needed. Furthermore, assessing whether the dugong conservation scheme offers value for money requires an inspection of the costs associated with it.

Conflict of interest

The authors declare that there is no conflict of interest.

Acknowledgments

We would like to express our appreciation to all anonymous reviewers for their constructive comments and feedback, which have helped to make this study complete.

References

Adamowicz W, Boxall P, Williams M, Louviere J. 1998. Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation. *American Journal of Agricultural Economics* 80 (1): 64-75.

Adulyanukosol K, Praittipornkul C, Anansap S, Boukaew P. 2009. Standing records of dugong (*Dugong dugon*) in Thailand. Proceedings of the 4th International Symposium on SEASTAR2000 and Asian Bio-logging Science (The 8th SEASTAR2000 workshop). https://core.ac.uk/download/pdf/39203986.pdf [Date accessed: 13 February 2018]

Alberini A, Longo A. 2006. Valuing environmental resources using stated preferences. In: Alberini A, Rosato P, Turvani M, editors, *Valuing Complex Natural Resource Systems: The Case of the Lagoon of Venice.* Cheltenham: Edward Elgar. pp 3-22.

Bennett J, Blamey R. 2001. The Choice Modelling Approach to Environmental Valuation. Massachusetts: Edward Elgar Publishing Limited.

Campbell D, Hutchinson WG, Scarpa R. 2008. Incorporating discontinuous preferences into the analysis of discrete choice experiments. Environ Resource Econ 41: 401-417.

Christie M, Warren J, Hanley N. Murphy K. Wright R. Hyde T. Lyons N. 2004. Developing Measures for Valuing Changes in Biodiversity: Final Report, Report to DEFRA London. www.cbd.int/financial/values/unitedkingdom-valumeasures.pdf [Date accessed: 8 December 2018]

Field BC, Field MK. 2009. Environmental Economics: An Introduction. 5th ed. New York: McGraw-Hill.

Hanley N, Spash CL.1993. *Cost-Benefit Analysis and the Environment*. Hants: Edward Elgar Publishing Limited.

Hanley N, Wright RE, Adamowicz W. 1998. Using choice experiments to value the environment: Design issues, current experience and future prospects. *Environmental and Resource Economics* 11 (3-4): 413-428.

Heinsohn GE, Wake J, Marsh H, et al. 1977. The dugong (*Dugong dugon* (Müller)) in the seagrass system. *Aquaculture* 12 (3): 235-248.

Hines EM, Adulyanukosol K, Duffus DA. 2005. Dugong (*Dugong dugon*) abundance along the Andaman coast of Thailand. *Marine Mammal Science* 21 (3): 536-549.

Marsh H (2017) Dugong (*Dugong dugon*). In: Perrin WF, Wursig BG, Thewissen JGM, editors. *Encyclopedia of Marine Mammals*, 3rd ed. London: Elsevier. pp. 274-277.

Marsh H, Eros C, Corkeron P, et al. 1999. A conservation strategy for dugongs: implications of Australian research. *Marine and Freshwater Research* 50: 979-990.

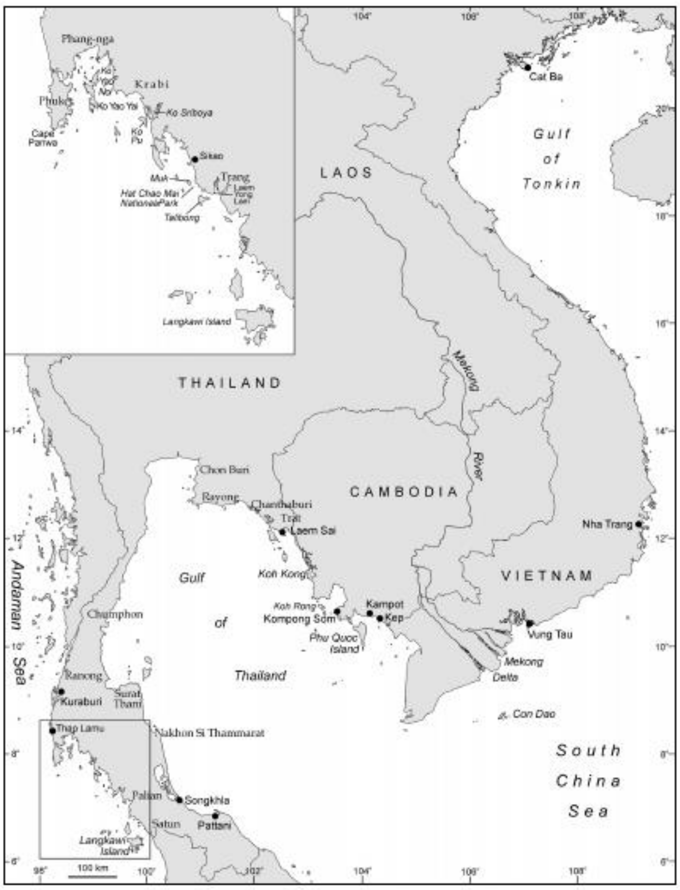
Pearce D, Atkinson G, Mourato S. 2006. Cost-Benefit Analysis and the Environment: Recent Development. Organisation for Economic Co-operation and Development, Paris.

Tisdell C. 2005. Economics of Environmental Conservation. 2nd ed. Cheltenham: Edward Elgar Publishing Limited.

Tunstall SM, Coker A. 1996. Survey-based valuation methods. In: Coker A, Richards C, editors, *Valuing the Environment: Economic Approaches to Environmental Evaluation*. West Sussex: John Wiley & Sons Ltd. pp. 104-126.

United Nations Environment Programme (UNEP). 2001. Dugong: Status Report and Action Plans for Countries and Territories, UNEP.http://www.unep.org/NairobiConvention/docs/dugong.pdf [Date accessed: 7 December 2018]

Wallmo K. 2003. Economic Choice Modeling: The Use of Social Preference Data to Inform White-Tailed Deer Management in Michigan. PhD thesis, Michigan State Univerisity, Michigan.



Source: UNEP (2001)

Figure 1. The distribution of dugongs in south Andaman region of Thailand

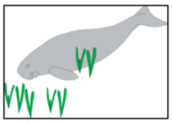
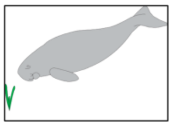
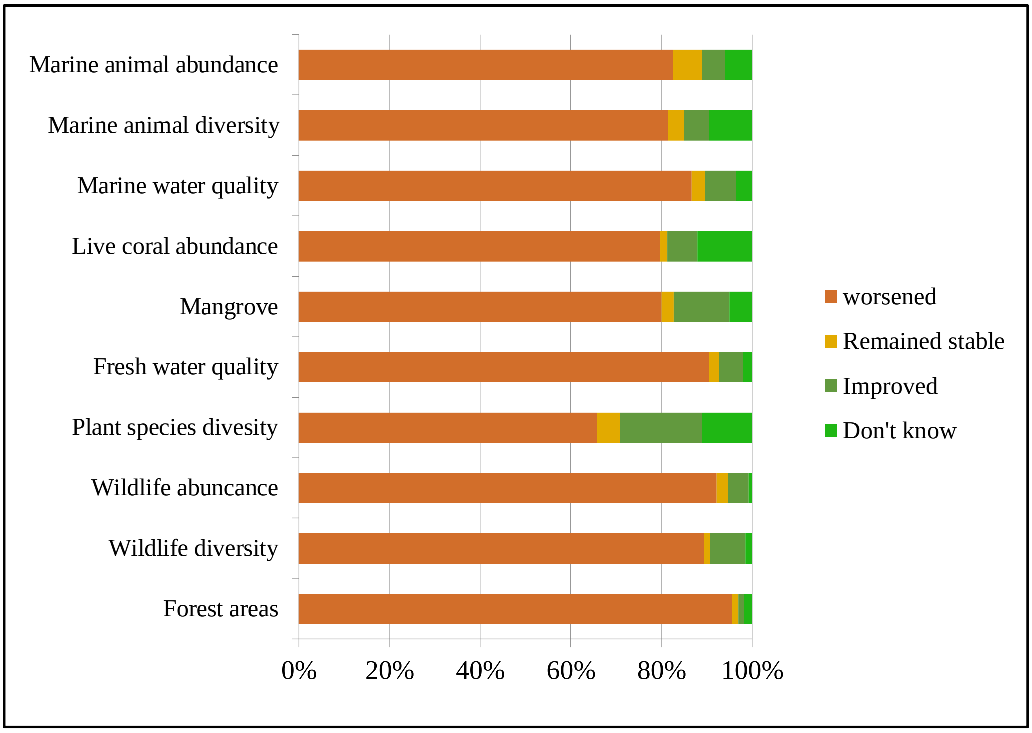
	Expected result in 10 years of each option	
	Option A	Option B
Dugong population	Continued decline	Recovery
Dugong habitat	 Re-creation	 Degradation
Knowledge of fishers (the number of local fishers who are educated about the dugong conservation)	A lot of fishers	A lot of fishers
Marker Buoy system (marker buoys are provided to identify dugong habitats where harmful fishing gears and high-speed boat are prohibited)	 Yes	 Yes
Contribution requested (added cost to your household each year for 10 years)	200 Baht/year	100 Baht/year
Which of the two options do you prefer?	[ ]	[ ]

Figure 2. Example of a choice set from a questionnaire



Share of respondents

Figure 3. Perception of change in Thailand's environment components

Table 1. The summary of selected attributes and their levels

Attribute	Level description	
1. Dugong population	Level 1: Continued decline	Status quo, no action (continued decline in the dugong population)
	Level 2: Slow down the decline	Slow down or halt the decline in the dugong population (may still become locally and nationally extinct)
	Level 3: Recovery	Stop decline and ensure recovery of the dugong population (local extinction would be removed)
2. Dugong habitat (Seagrass Beds)	Level 1: Degradation	Status quo, no action (dugong habitats will continue to be degraded and lost)
	Level 2: Restoration	Habitat restoration (better management of existing habitats)
	Level 3: Recreation	Habitat recreation (creating new habitats for dugongs)
3. Knowledge of fishers	Level 1: Some fishers	Some local fishers are educated about the dugong conservation
	Level 2: A lot of fishers	A lot of local fishers are educated about the dugong conservation
4. Marker buoy system	Level 1: No buoy	Status quo (buoys are not provided)
	Level 2: Yes	Buoys are provided in seagrass areas, dugong habitats so that fisher know the area where harmful fishing gears and high-speed boats are prohibited
5. Yearly contribution (in Thai Baht)	0, 100, 200, 500, 1000	Added to each household for using an effective dugong conservation scheme for 10 years

USD1 = 33.60 Thai Baht

Table 2. Perceived threats to dugongs in Thailand

Rank	Perceived threats to dugongs	Number respondents 1st most important	Number respondents 2nd most important	Number respondents 3rd most important	Weight (Points)	Importance (%)
1	Inshore fishing pressure (e.g. trawling)	84	94	46	486	54.0
2	Accidental caught	77	45	52	373	41.4
3	Habitat loss and degradation as a result of water pollution	55	66	54	351	39.0
4	Vessel strikes	33	45	31	220	24.4
5	Hunting and use	46	19	15	191	21.2
6	Natural predators or diseases	2	18	59	101	11.2
7	Coastal development	3	13	32	67	7.4

Table 3. Perception of required measures for dugong conservation

Rank	Perceived measures	Number respondents			Weight (Points)	Importance (%)
		1st most important	2nd most important	3rd most important		
1	Prohibited trawling	95	46	32	409	45.4
2	Increased penalties	47	78	33	330	36.7
3	Implementing buoy systems	37	68	50	297	33.0
4	Expanded marine protected areas	67	29	35	294	32.7
5	Raising awareness	39	48	63	276	30.7
6	International cooperation	8	23	58	128	14.2
7	Research and monitoring	7	8	25	62	6.9

Table 4. Estimation results

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
POP_SLOW DOWN	1.47362	.12697	11.606	.0000
POP_RECOVERY	.97018	.16859	5.755	.0000
HAB_RESTORATION	2.26549	.15395	14.716	.0000
HAB_RECREATION	2.49445	.13012	19.197	.0000
KNOWLEDGE	-3.16431	.14653	-21.595	.0000
BUOY	4.66342	.22317	20.896	.0000
PRICE	-0.00196	.00019	-10.346	.0000
Log-likelihood		-1449.661		
No. Observations		2400		

Table 5. Average WTP for a change in each attribute level

Improvement	WTP (Baht/household /year)	Standard Error	b/St.Er.	P[|Z|>z]
Dugong population: Slowdown the Decline	748.19	78.20135	9.567	.0000
Dugong population: Recovery	492.58	78.50481	6.274	.0000
Dugong habitats: Restoration	1150.24	91.47554	12.537	.0000
Dugong habitats: Re-creation	1266.48	90.80566	13.947	.0000
Knowledge of fishers: Good	-1606.59	109.86242	-14.624	.0000
Marker buoys: Exist	2367.71	140.66155	16.833	.0000

USD =33.60 Thai Baht