Ocean and Coastal Management 212 (2021) 105848

Contents lists available at ScienceDirect

Ocean and Coastal Management

journal homepage: www.elsevier.com/locate/ocecoaman

A comparative method for evaluating ecosystem services from the viewpoint of public works

Tomonari Okada [a,*], Yugo Mito [b], Kanae Tokunaga [c], Hiroaki Sugino [d], Takahiro Kubo [e], Yoshihiro B. Akiyama [a], Toru Endo [f], Sosuke Otani [g], Susumu Yamochi [h], Yasunori Kozuki [i], Takayuki Kusakabe [j], Koji Otsuka [k], Ryoichi Yamanaka [i], Takaaki Shigematsu [f], Tomohiro Kuwae [l]

[a] Marine Environment Division, Coastal, Marine and Disaster Prevention Department, National Institute for Land and Infrastructure Management, 3-1-1 Nagase, Yokosuka, Kanagawa, 239-0826, Japan
[b] Fukken Co., Ltd, Tokyo Branch Office Tokyo, 3-8-15 Iwamoto-Cho, Chiyoda-Ku, Tokyo, 101-0032, Japan
[c] Coastal & Marine Economics Lab, Gulf of Maine Research Institute, 350 Commercial St, Portland, ME, 04101, USA
[d] Graduate School of Agricultural and Life Sciences, The University of Tokyo, 1-1-1 Yayoi, Bunkyo-ku, Tokyo, 113-8657, Japan
[e] Center for Environmental Biology and Ecosystem Studies, National Institute for Environmental Studies, 16-2 Onogawa, Tsukuba-City, Ibaraki, 305-8506, Japan
[f] Graduate School of Engineering, Osaka City University, 3-3-138 Sugimoto, Sumiyoshi-ku, Osaka City, Osaka, 558-8585, Japan
[g] Civil Engineering and Environment Course, Osaka Prefecture University College of Technology, 26-12 Saiwaicho, Neyagawa, Osaka, 572-8572, Japan
[h] Osaka City University, 3-3-138 Sugimoto, Sumiyoshi-ku, Osaka City, Osaka, 558-8585, Japan
[i] Research Center for Management of Disaster and Environment, Tokushima University, 2-1 Minamijyousanjima-cho, Tokushima, 770-8506, Japan
[j] Research Institute of Environment, Agriculture and Fisheries, Osaka Prefecture, 442 Shakudo, Habikino, Osaka, 583-0862, Japan
[k] Graduate School of Humanities and Sustainable System Sciences, Osaka Prefecture University, 1-1 Gakuen-cho, Naka-ku, Sakai, Osaka, 599-8531, Japan
[l] Coastal and Estuarine Environment Research Group, Port and Airport Research Institute, 3-1-1 Nagase, Yokosuka, Kanagawa, 239-0826, Japan

ARTICLE INFO

Keywords:
Ecosystem services
Economic value
Wetland
Restoration
Nature-based solutions

ABSTRACT

Nature-based solutions (NbS), such as the implementation of environmental conservation and restoration as public works projects, require accurate and cost-effective assessments of the values related to the projects. The values should represent collective ecosystem services, individual services such as food provision and water purification, and other intangible services. To comprehensively assess such services, we proposed a novel method, which we call the comparative evaluation method. Our method is able to assess the value of each service category of an NbS project from a single questionnaire survey. Survey participants are asked to compare values of multiple services having anchoring prices. Our method determines the permissible economic value of environmental public works (PEP) in response to the quantity of service. The questionnaire results used for analysis are limited to those from respondents who made their PEP evaluation on the basis of their consideration of the appropriate expenditure of taxes. In addition, the method controls for the effect of the satisfaction that a person experiences from doing good deeds to reduce an overestimation of the values of services. Moreover, PEPs are not influenced by the respondent's annual income, age, sex, or educational background, and are based on personal values. Applying this new method, we surveyed residents of the watersheds of Tokyo Bay and Osaka Bay and evaluated nine ecosystem services. Overall, our new method is shown to be an effective method for evaluating the ecosystem services of NbS projects from the viewpoint of public works.

1. Introduction

The degradation of ecosystems and ecosystem services has an irreversible impact on our societies (Costanza et al., 1997; Millennium Ecosystem Assessment, 2005). Climatic change and species extinction are progressing worldwide, and ecosystem conditions continue to worsen (McLeod et al., 2011; Costanza et al., 2014). In response to these changes, nature-based solutions (NbS) such as nature-based or green–gray infrastructure projects, which combine conservation and restoration of ecosystems with the selective use of conventional engineering

* Corresponding author.
E-mail address: okada-t92y2@mlit.go.jp (T. Okada).

https://doi.org/10.1016/j.ocecoaman.2021.105848
Received 19 April 2021; Received in revised form 6 July 2021; Accepted 9 August 2021
Available online 20 August 2021
0964-5691/

approaches, have the potential to deliver climate change resilience and adaptation benefits (Kuwae and Crooks, 2021). NbS are defined as 'actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits' (IUCN , 2016). As the social and economic impacts of the deterioration of ecosystems and ecosystem services become more pronounced, NbS projects, such as those related to environmental conservation, restoration, and the creation and promotion of green infrastructure, will become increasingly important.

Coastal areas account for a large percentage of global ecosystem services (de Groot et al., 2012; Costanza et al., 2014). The Blue Carbon Report estimates that coastal regions, which constitute only 1% of the world's total ocean area, account for 73%–79% of ocean carbon stocks (McLeod et al., 2011). Coastal regions are considered to be among the key areas for controlling the degradation of global ecosystems and ecosystem services, but many have been highly developed (Barbier, 2012) and have been reclaimed. As a result, the habitats of many organisms have deteriorated. In Japan, during the period of high economic growth (1950s–1970s), many coastal regions suitable for port logistics were developed as industrial and logistics bases (Furukawa and Okada, 2006). To mitigate coastal degradation, environmental improvement and rebuilding projects in coastal regions are underway worldwide (Elliott et al., 2007; Kim et al., 2017; PIANC, 2018; Reguero et al., 2018; Duarte et al., 2020). In Japan, a number of wetlands (tidal flats) and areas that support marine vegetation (seagrass meadows and macroalgal beds) have been created to restore lost habitats (Furukawa, 2013; Furukawa et al., 2019). In addition, green port structures (i.e. nature-based infrastructure in ports and harbors) featuring habitats for marine organisms have been promoted as part of a comprehensive policy to reduce the environmental impact of ports and carry out habitat conservation, restoration, and creation (Okada et al., 2021; Mito et al., 2021).

Such marine NbS projects are often implemented as public works. To promote these types of projects as sustainable public works in the future, the ecosystem services of the projects need to be appropriately assessed and used to set policy (Wang et al., 2010; Bullock et al., 2011; Schlacher et al., 2014; O'Connor et al., 2020; Tyner and Boyer, 2020). In addition, appropriate planning is required to maximize the ecosystem services created by these projects to use tax revenue effectively, and proper management practices are needed to ensure the sustainability of the ecosystem services. These tools require a method that can accurately evaluate the economic value and sustainability associated with the social and ecological conditions of a given project (García-Onetti et al., 2018).

To address this need, we developed the following three-step approach: (1) scoring individual ecosystem services linked to social and ecological conditions, (2) assigning relative weights for individual ecosystem services, and (3) producing a comprehensive estimate of ecosystem services.

We previously proposed a scoring method to assess ecosystem services of environmental improvement projects (i.e. NbS projects) in coastal regions (Okada et al., 2019). There, we divided the overall ecosystem services attributable to tidal flats into 12 services. We then scored each individual service in relation to environmental factors in natural systems (e.g. dissolved oxygen, ground stability, and predatory or competitive species) and social systems (e.g. management of habitat conditions, incidental facilities, and accessibility). By using the method, we also evaluated the ecosystem services provided by NbS projects in two highly urbanized bays (Tokyo Bay and Osaka Bay) in Japan and showed the characteristics of the ecosystem services provided by them (Okada et al., 2021).

The next step was to determine the relative weight of each ecosystem service. Here, conventional economic assessments can be made by applying various environmental economics approaches (Gómez-Baggethun et al., 2010). Because stated preference methods, which estimate values by asking individuals survey questions related to their preferences and inferring values from their stated responses (Champ et al., 2017), are applicable to nearly all ecosystem services, they are preferable to assess multiple ecosystem services simultaneously; however, they pose some problems in determining the economic value of multiple ecosystem services.

Survey scenario design is known to influence the reliability and validity of the estimated willingness to pay (WTP) when using stated preference methods (Arrow et al., 1993; Hanley et al., 1998). It is difficult to develop a generalizable hypothetical scenario of an environmental public works project because the hypothetical scenario depends on social circumstances (e.g. the economic cycle and degree of urbanization) in which the individual projects are being implemented. In addition, the stated preference method can be costly, especially if it involves multiple ecosystem services. The contingent valuation method (CVM) uses questionnaires to ask people about their WTP to increase or enhance the provision of an ecosystem service, or alternatively, how much they would be willing to accept for its loss or degradation (TEEB, 2010). It requires respondents to indicate WTP multiple times to assess multiple ecosystem services. With choice experiments (CEs), which ask respondents to estimate the relative value of different attributes of a service (TEEB, 2010), the respondents face more complex choices as the number of attributes increases (Champ et al., 2017). The objective of CVM is to solicit individual valuation. Thus, methodological development in stated preference methods have focused mainly on survey design and implementation techniques to ensure the validity of the estimated environmental values. Methodological challenges such as hypothetical biases that are inherent in contingent valuation can be overcome by following the suggested design and implementation guidelines (Carson, 2012; Kling et al., 2012). Yet, as Freeman et al. (2014) note, the theoretical construct investigated by contingent valuation is perceived individual value, which partly explains why the WTP values obtained by stated preference methods often depend on personal attributes. For example, significant relationships are often found between WTP and an individual's economic attributes, such as income and home ownership (e.g. Blackburn et al., 1994; Nunes and Schokkaert, 2003; Agimass and Mekonnen, 2011), implying that such individual characteristics are a potential influencing factor in WTP evaluations. In addition, a neoclassical economics approach to setting environmental policy does not represent democratic value because it prioritizes individual values over social value (Kenter et al., 2015; Lo and Spash, 2012). Traditionally, economic valuation studies have implicitly assumed that collective value can be obtained by aggregating individual values, but researchers in other disciplines have argued otherwise. For example, Neilson and Wichmann (2014) showed the significance of social networks in non-market valuations, arguing that individual private value may differ from social value. If we take the view that contingent valuation solicits individual private value in isolation from other people, then simply aggregating individual WTP values obtained from contingent valuation will fail to capture the additional benefits created from social interactions. Kenter et al. (2015) stated that one-dimensional economic valuation approaches, including contingent valuation, fail to derive the shared and social values of the environment by ignoring the shared and collective significance and meanings ascribed to the environment.

Although the ecosystem services framework has contributed to shape policies for environmental protection and provided policy tools, including those that rely on market-based mechanisms, the framework has been criticized for its utilitarian framing and commodification of nature (Gómez-Baggethun et al., 2010; Braat and de Groot, 2012). More recently, the concept of relational value has emerged to broaden the valuation framework to allow for plural values (Arias-Arévalo et al., 2017; Chan et al., 2018). Relational value, described as 'preferences, principles, and virtues about human-nature relationships' (Chan et al., 2016), captures the value that cannot be recovered by instrumental or intrinsic values in ecosystem service valuations. The notion allows us to elucidate 'what people find meaningful about nature' (Chan et al., 2018). Moreover, studies suggest that excluding relational values in decision making could lead to canceled projects, added financial costs, and relational harm (e.g. Grubert, 2018).

These recent developments in the ecosystem services literature offer useful insight to approaches that can be used to solicit the public's preferences toward environmental public works projects. What is important in public works is not whether individuals are willing to pay for public works, but whether they would support tax expenditures for these public works. In assessing public works, it would seem more important that the cost of a proposed project not exceed the economic value that the public approves of for that project rather than that the cost of the project be less than some collective WTP amount. The primary reason for this is that, in the case of public works, existing taxes are commonly allocated to support a new project, which means that no new taxes are being imposed. Approaches such as the Deliberative Democratic Monetary Valuation method have been developed to measure this type of social WTP (Orchard-Webb et al., 2016). However, this method requires a relatively large commitment of time and effort for deliberations by stakeholders. Therefore, based on the idea that it is more appropriate to evaluate NbS projects as public works expenditures, we introduced the new concept of permissible economic value of public works (PEP), which is defined as the acceptable cost (in monetary terms) for ecosystem services in a public works project.

In this study, we propose a novel stated preference method for assessing the PEP for the ecosystem services of NbS projects from the viewpoint of public works. In this method—which we call the comparative evaluation method—we focused on wetlands (tidal flats) because the creation of artificial tidal flats is a popular NbS project in Japan.

2. Method

2.1. Evaluated tidal flats and survey targets

The need for more NbS projects has been widely recognized, particularly in highly developed urban coastal areas. In Japan, artificial tidal flats have been created in many of the major coastal cities. For this study, we selected the bays of Tokyo and Osaka, Japan's two largest cities, as the water research areas for our study site (Furukawa and Okada, 2006). The survey area was set as the watersheds of Tokyo Bay and Osaka Bay (Fig. 1), in each of which we evaluated four tidal flats. From the viewpoint of public works, it might be reasonable to conduct a nationwide survey, but we were concerned that the large number of responses from people not familiar with the target water areas could adversely affect results. At the same time, if the survey were administered only to residents living near the target tidal flats and people in the coastal areas, the respondents might represent a group with biased values. In Tokyo Bay, the Tokyo Bay Renaissance Project (https://www1.kaiho.mlit.go.jp/KANKYO/TB_Renaissance/index.html) has been introduced as a framework for integrated coastal zone management. In Osaka Bay, the Osaka Bay Renaissance Project (https://www.kkr.mlit.go.jp/plan/suishin/) has a similar role. In both frameworks, the environment of the entire bay is taken into account, including not only the sea area but also the drainage basin of each bay. For these reasons, we selected the watersheds of the two bays as the survey target.

The Tokyo Bay drainage basin includes Tokyo, the largest city in Japan, which has a population of approximately 30 million people. The Osaka Bay drainage basin includes Osaka, the third largest city in Japan, with a population of approximately 20 million. Eutrophication is extensive in both bays, and phytoplankton blooms and hypoxia occur every summer (Furukawa and Okada, 2006). Thus, both bays are urban, eutrophic bays.

2.2. Setting environmental benefits and indices

Okada et al. (2019) identified 12 services derived from tidal flats: food provision, coastal protection, recreation, environmental education, research, historical designation as a special site, a place for everyday rest and relaxation, removal of suspended matter, organic matter

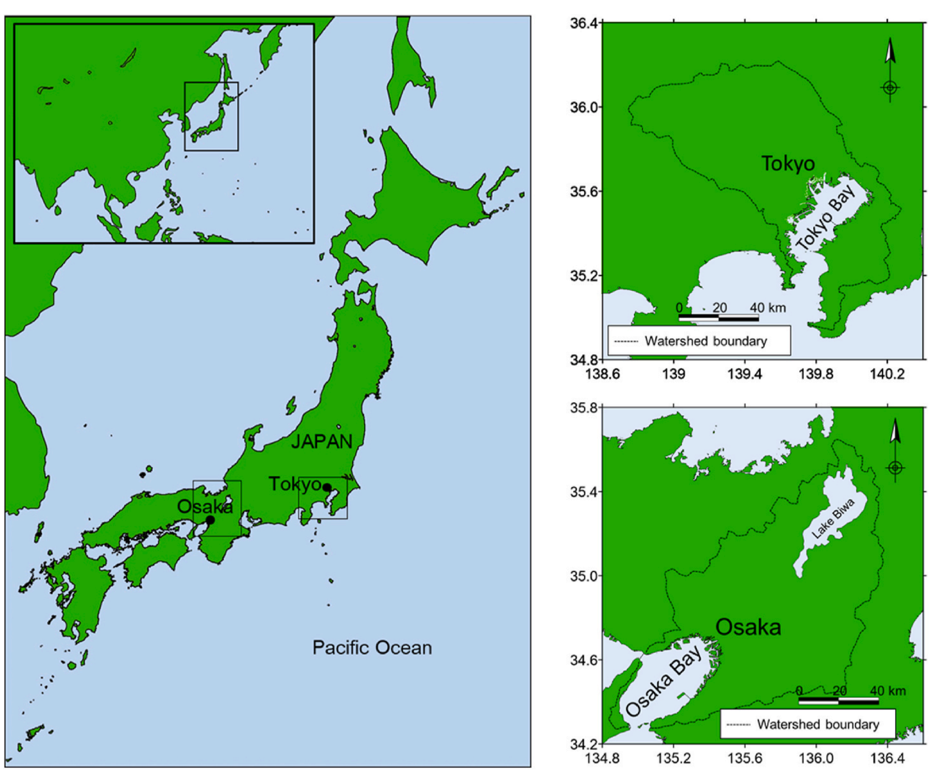


Fig. 1. Surveyed drainage basin areas.

decomposition, carbon storage, degree of diversity, and rare species. In this study, as with Okada et al. (2021), the list of services was revised to avoid double counting services (Table 1). The indices of these services were standardized by converting to amounts per unit time (flow units), thus making it possible to sum individual economic values. Moreover, the names of three of the services, global warming mitigation, historical site and everyday relaxation, have been slightly modified from those used in Okada et al. (2019) (where they were called 'carbon storage', 'historical designation as a special site' and 'everyday rest and relaxation', respectively) for clarity.

2.3. Comparative evaluation method

2.3.1. Overview of comparative evaluation method

The most challenging problem when conducting a survey to determine PEPs is that it is difficult for people who have not been directly involved in public works to evaluate, in absolute terms, the value of public works expenditures. In countries where the financial status of government agencies is open to the public, there is much debate about the appropriateness of various public works. When asked to assess the cost/benefit of a proposed public works project, however, relatively few individuals are capable of providing a direct answer.

Consequently, recognizing that relative evaluation is considered easier than absolute evaluation (Arrow et al., 1993), we devised our method to produce PEPs based on relative comparisons of ecosystem services. An outline of our method's process is shown in Fig. 2. The method determines the PEPs of the services to be evaluated (SEs) by using the economic value of another service that can be measured by applying the revealed preference method. We refer to these more directly measurable services as standard services (SSs). The value of the food provision SS was calculated by using the market price method, with fish catch as the index. The replacement cost method was used for the water purification SS, with the COD purification amount as the index. The SS values for recreation and everyday relaxation were calculated by using the travel cost method, with the number of visitors for each purpose as the index and questionnaire survey results in site. In this study, the SSs are food provision, water purification, recreation, and everyday relaxation; the SEs are global warming mitigation, environmental education, research, historical site, and species conservation.

The method employs a survey questionnaire to determine the PEPs of the various SEs in a two-step procedure (Fig. 2). In Step 1, the index quantities of an SE and an SS are presented. The respondent is then asked to choose the alternative with the greater level of service. After making his/her choice, the respondent is told the economic value of the SS, as determined by the revealed preference method. In Step 2, the respondent selects a PEP (a monetary value) for the target SE by using the dichotomous choice method.

Table 1
Services, value of specific contents of services, indices of services provided, and index units of tidal flat ecosystems.

Service	Value of specific content	Index	Unit
Food provision	Supplying seafood as food	Annual catch	t ha^{-1} year^{-1}
Water purification	Organic matter decomposition function	Annual COD-removal amount	t-COD ha^{-1} year^{-1}
Global warming mitigation	Carbon storage in organisms and sediment	Annual carbon storage	t-C ha^{-1} year^{-1}
Recreation	Marine leisure	Annual visitors for recreation	Number of visitors ha^{-1} year^{-1}
Environmental education	Environmental education	Annual visitors for environmental education	Number of visitors year^{-1}
Research	Research	Number of annual reports and papers	Papers year^{-1}
Historical site	Festivals and rituals	Number of annual rituals and festivals	Number held year^{-1}
Everyday relaxation	Rest and relaxation	Annual visitors for rest and relaxation	Number of visitors ha^{-1} year^{-1}
Species conservation	Existence of diverse species	Number of annual confirmed species	Species year^{-1}

2.3.2. Questionnaire design

2.3.2.1. Relative comparisons of ecosystem services (step 1). In the survey questionnaire, the respondent is presented with the index quantities for an SE and an SS and is asked to choose which of the two is more valuable as a public work. The respondent's answer determines the importance of the SE relative to the SS. The index quantities serve as a reference point (score = 100) in the ecosystem services scoring method, as proposed in Okada et al. (2019) (Table 2): here, the maximum observed value for each index in the four tidal flats in each bay in the most recent 5-year period is used as the reference point for the index. By aligning the index quantity with the reference point, different services can be compared at the same level.

2.3.2.2. Evaluation of PEP (step 2). To produce the PEP, we adopted the single-bounded dichotomous choice method, which were less burdensome to respondents than the others. After the economic value of the SS is revealed to the respondent, a proposed PEP (i.e. a bid) is presented to the respondent, who then is asked whether the proposed PEP is appropriate for the SE. In other words, the respondent is asked whether they believe that the proposed bid amount reflects the worth of the SE (more specifically, whether the respondent thinks the SE is worth more than the bid amount). In addition to the standard 'yes' and 'no' response options, a 'no-answer' option was included. This allowed us to exclude low-reliability responses of respondents who were confused by the question. The bid amounts for the PEP were determined in a pre-test exercise using the card selection method; the pre-test included 250 residents living in the drainage basin of Tokyo Bay. In the pre-test, the bid amount was changed in 10 steps, from 100 thousand JPY[1] ha^{-1} year^{-1} (nearly 1,000 USD ha^{-1} year^{-1}) to 10 billion JPY ha^{-1} year^{-1} (nearly 100 USD million ha^{-1} year^{-1}). The maximum bid in the pre-test turned out to be 100 million JPY ha^{-1} year^{-1} (approximately 1 million USD ha^{-1} year^{-1}). Based on this result, the bid amount (JPY ha^{-1} year^{-1}) presented in the questionnaire was set at 1, 5, 10, 25, 50, and 100 million (approximately 10, 50, 100, 250, 500, and 1000 thousand USD ha^{-1} year^{-1}). The calculation method of the PEP is shown in section 2.3.5.

Following the respondent's answer to the dichotomous choice question, he/she was then asked to indicate the 'Reason for your answer'. The response options consisted of the following five choices: (1) I calculated and evaluated from the number and scale of the service (hereafter, 'Quantity'); (2) I evaluated the service in consideration of social and public effects (hereafter, 'Society'); (3) I evaluated the service in consideration of it being an important service for me (hereafter, 'Individual'); (4) I evaluated the service in consideration of the appropriate tax expenditure (hereafter, 'Tax'); and (5) I did not have a good understanding of the meaning of the question.

2.3.2.3. Cases involving a combination of SE and SS. Our method evaluates SEs and SSs on the basis of one-to-one comparisons. To efficiently compare all services, we created four cases involving a combination of SEs and SSs (Table 3). The method originally evaluated the five SEs as targets. However, to examine the difference between the PEP and the economic values calculated by the revealed preference method, one SS

[1] JPY: Japanese Yen; 100 JPY = 0.92 USD in January 2019.

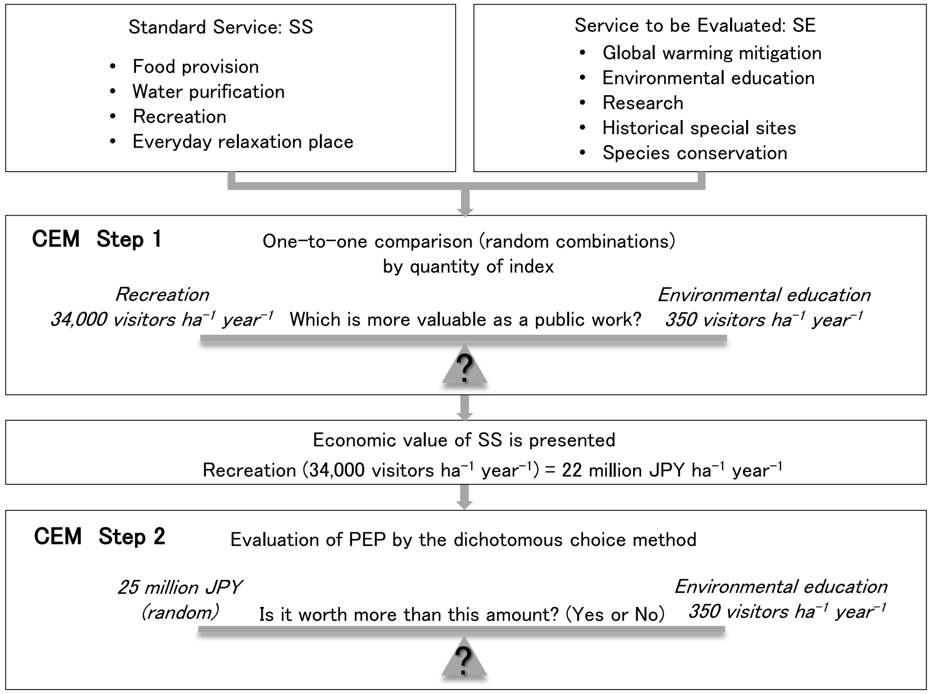


Fig. 2. Overview of the comparative evaluation method (CEM). JPY: Japanese Yen; 100 JPY = 0.92 USD in January 2019.

Table 2
Services, quantities, and economic values shown in the questionnaire. (a) Tokyo Bay and (b) Osaka Bay.

Type	Service	Quantity (reference point of index)	Unit for index	Economic value (JPY[a] ha^{-1} year^{-1})
Standard service	Food provision	(a) 9.0 (b) 10.0	t ha^{-1} year^{-1}	(a) 3.5 million (b) 4.8 million
	Water purification	(a) 7.0 (b) 8.0	t-COD ha^{-1} year^{-1}	(a) 12 million (b) 12 million
	Recreation	(a) 34,000 (b) 8,000	Number of visitors ha^{-1} year^{-1}	(a) 22 million (b) 7.5 million
	Everyday relaxation	(a) 10,000 (b) 9,000	Number of visitors ha^{-1} year^{-1}	(a) 10 million (b) 4 million
Service to be evaluated	Global warming mitigation	(a) 1.0 (b) 1.0	t-C ha^{-1} year^{-1}	NA
	Environmental education	(a) 350 (b) 700	Number of visitors year^{-1}	NA
	Research	(a) 14 (b) 7.0	Papers year^{-1}	NA
	Historical site	(a) 2.0 (b) 1.0	Numbers of held year^{-1}	NA
	Species conservation	(a) 100 (b) 100	Species year^{-1}	NA

[a] JPY: Japanese Yen; 100 JPY = 0.92 USD in January 2019.

was added as an evaluation target in each case (the evaluation SS or E-SS). In each case, one SS was selected as the E-SS and was compared with a different randomly selected SS (see Table 3). With these four cases, all combinations of SE/SS and E-SS/SS pairs could be analyzed. In addition, to exclude the effect of question order, the question order followed two patterns, with one being the reverse of the other. The respondents answered the questions for only one case.

2.3.2.4. Quantification of individual characteristics by the norm activation model. The norm activation model can be used to explore behaviors and attitudes toward environmental conservation insofar as these behaviors and attitudes are closely related to social norms (Blamey, 1998; De Groot and Steg, 2009; Borger and Hattam, 2017). This model considers three main factors associated with altruistic behavior: awareness of responsibility (AR), awareness of consequences (AC), and awareness of personal cost (APC) (Schwartz, 1977). To analyze how social norms affect PEPs, we used the model to quantify the norm awareness of respondents.

In our survey, we included the following 12 statements based on the norm activation model for the three awareness categories (AR, AC, and APC).

1. It goes against my intentions to burden my household finances with a project that improves the Tokyo Bay environment.
2. Those who use the land-fill coastal areas, such as companies and governments, are responsible for the environmental degradation of Tokyo Bay.
3. It is my loss to pay for the recovery of Tokyo Bay coastal areas.
4. I think if we take no action, it will not be possible to restore the rich natural environment in Tokyo Bay.
5. Whether we can recover the natural environment in Tokyo Bay or not is not really an important problem.

Table 3
Combinations of standard service (SS), service to be evaluated (SE), and evaluated SS (E-SS). The target is the evaluation target.

		Case 1		Case 2		Case 3		Case 4	
		Target	SS	Target	SS	Target	SS	Target	SS
SE	EE	●	RC	●	ER	●	WP	●	FP
	RS	●	ER	●	WP	●	FP	●	RC
	HS	●	WP	●	FP	●	RC	●	ER
	SC	●	RC	●	ER	●	WP	●	FP
	GM	●	ER	●	WP	●	FP	●	RC
E-SS	FP	●	Random[a]						
	RC			●	Random[b]				
	ER					●	Random[c]		
	WP							●	Random[d]

EE: Environmental education, RS: Research, HS: Historical site, SC: Species conservation, GM: Global warming mitigation, FP: Food provision, RC: Recreation, ER: Everyday relaxation, WP: Water purification.
[a] Randomly set for each respondent from among RC, ER, and WP.
[b] Randomly set for each respondent from among FP, ER, and WP.
[c] Randomly set for each respondent from among FP, RC, and WP.
[d] Randomly set for each respondent from among FP, RC, and ER.

6. We should leave Tokyo Bay's natural environment to chance.
7. I do not think Tokyo Bay's natural environment is seriously degraded.
8. In general, activities that protect the natural environment prevent free economic activity.
9. I think it is possible to regenerate the natural environment in Tokyo Bay if the people who live in the Tokyo Bay coast prefectures cooperate with each other.
10. The future of Tokyo Bay's coastal environment depends on our actions.
11. No matter what others do, I feel that I am responsible for nurturing a rich natural environment in Tokyo Bay.
12. Improvement of the Tokyo Bay natural ecosystem is my responsibility.

A five-point Likert scale from 'not applicable' to 'applicable' was used for responses. Although these statements were specifically framed in the Tokyo Bay environmental context (Tokunaga et al., 2019), we used the same set of statements in the evaluation of Osaka Bay, except the phrase 'Tokyo Bay' was replaced with 'Osaka Bay'. Factor analysis was used to produce factor scores for each respondent. The factor scores were subsequently analyzed using a multinomial logit model, with the reason for the respondent's answer serving as the criterion value. The factor analysis was conducted with the R (version 3.5.1) 'psych' software package (Revelle, 2018); the multinomial logit model analysis was conducted with the 'mlogit' package (Croissant, 2010).

2.3.2.5. Other questions. Questions regarding individual attributes were included in an attempt to identify variables that might affect a respondent's answers. The questions focused on the respondent's awareness of environmental problems, knowledge of the marine environment, age, sex, and annual individual income. To assess the respondent's awareness of environmental issues, each respondent was asked to indicate, on a five-point scale ranging from 'not important' to 'important', the importance of seven environmental issues that have been widely discussed in Japan in recent years. To assess the respondent's knowledge of the marine environment, 11 keywords related to the marine environment were presented; the respondent was then asked to indicate how many of the words he/she knew and understood.

A screening question specific to web surveys was included at the beginning of the survey to remove mechanical responses. Because respondents who understood the relationship between public works expenses and economic value were viewed as most desirable in this survey, a screening question on this relationship was also included. Details about the survey questions are given in Table S1.

2.3.3. Implementation of the survey

Because the cases involving the combinations of SEs and SSs were complicated, an efficient survey method was needed. For this reason, we chose to conduct an Internet survey. The survey company (Rakuten Insight, Inc.) selected for the study has the largest number of monitors in Japan. Approximately 0.7 million and 0.4 million monitors, respectively, are registered with this company in the watersheds of Tokyo Bay and Osaka Bay.

Based on a power analysis from the pre-test and sample representativeness, we determined that more than 400 respondents would be needed for the sample. In the pre-test, the residual response rate after removing biased responses was approximately 40%. Therefore, a sample size of 1,200 was set, allowing for a reasonable safety margin.

The survey was conducted among residents registered as monitors with the survey company in each of the two watersheds. Because there are multiple local governments in each area (four in the Tokyo Bay area, six in the Osaka Bay area), the sample collection rate was based on the populations of these local governments. Age and gender were also used in determining sample composition. The survey began on January 10, 2019 and was completed on January 15, 2019.

2.3.4. Analysis of PEP

In calculating the PEP, we used a random utility model (Hanemann and Kanninen, 1996) capable of incorporating the effects of various factors that might influence it. In the random utility model, the probability that the respondent selects 'yes' or 'no' for a given bid is expressed by Eqs. (1) and (2):

$$\Pr[Yes] = P_{yes} = 1 - G \tag{1}$$

$$\Pr[No] = P_{No} = G \tag{2}$$

where $\Pr[**]$ is the selection probability of each of the dichotomous choices ('yes' or 'no'), and G is a cumulative distribution function. Assuming that G is a logistic distribution, G is expressed by the logit model

$$G = 1 - \frac{1}{1 + exp[-\Delta V]} \tag{3}$$

where ΔV is the utility difference between the bid amount and the PEP. ΔV is defined by Eq. (4):

$$\Delta V = \beta_0 - \beta_1 \times \ln T + \beta_2 \times Es + \beta_3 \times C + \sum_{k=4}^{n+4} (\beta_k \times x_k) \tag{4}$$

where T is the bid; C is the reason for the answer; Es is the SS type; x_k is individual attribute k; n is the number of individual attributes; β_1, β_2, and β_3 are coefficients for each explanatory variable; β_k is the coefficient of individual attribute x_k; and β_0 is the intercept. Note that C, Es, and x_k are categorical variables.

Because the random utility model did not produce significant coefficients for bid (see Section 3.3), we calculated the PEP by applying a nonparametric survival analysis (Turnbull, 1974). Here, the PEP was calculated by replacing the survival time in the nonparametric survival analysis with the bid; a cumulative survival curve was drawn showing a decrease in the probability of approval as the bid amount is increased. In calculating the PEP, a 95% confidence interval was produced by using the bootstrap method:

$$P_{yes}(T_t) = 1 - F(T_t) = \frac{1}{n}\sum_{i=1}^{n}\delta \tag{5}$$

where $P_{yes}(T_t)$ is the probability of approval for bid t, n is number of respondents, $F(T_t)$ is the lifetime distribution, and δ is a dummy variable where $\delta = 1$ if respondents approve of bid t and $\delta = 0$ otherwise.

The calculations were conducted using the R (version 3.5.1) 'DCchoice' software package (Nakatani et al., 2016).

2.4. *Confirmation of the relative value of ecosystem services using the Best-Worst scaling method*

As described, our method determines PEPs based on relative comparisons of services. For the method to be considered appropriate, its results must be consistent with those of other methods assessing utility differences via relative comparisons. To check for consistency, the Object Case Best-Worst Scaling (BWS) method was applied to the same nine services evaluated by our approach (Louviere et al., 2015). The index quantities of the nine services were set to the same values as the index quantities used in our method. The choice sets were created by using a balanced incomplete block design (R 'support.BWS' package; Aizaki, 2015).

The BWS survey was conducted by the same survey company, and the area was again set as the watersheds of Tokyo Bay and Osaka Bay. The coefficients for the nine services were calculated using the conditional logit model (R 'gmnl' package; Sarrias et al., 2018) and served as the BWS scores. The sample size was 200 in each bay.

3. Results

3.1. *Number of valid responses*

Responses to the question concerning the respondent's understanding of the relationship between public works expenditures and the estimated economic values of the project, which served as the screening question, excluded the largest number of sample respondents for all versions of the survey (Table S1: Question 7) (Fig. 3). About 20%–30% of the respondents answered incorrectly and were thus excluded from the analysis. We believe that such screening is necessary to ensure reliable PEPs. The response that excluded the second largest number of respondents was the 'no-answer' response in the dichotomous choice

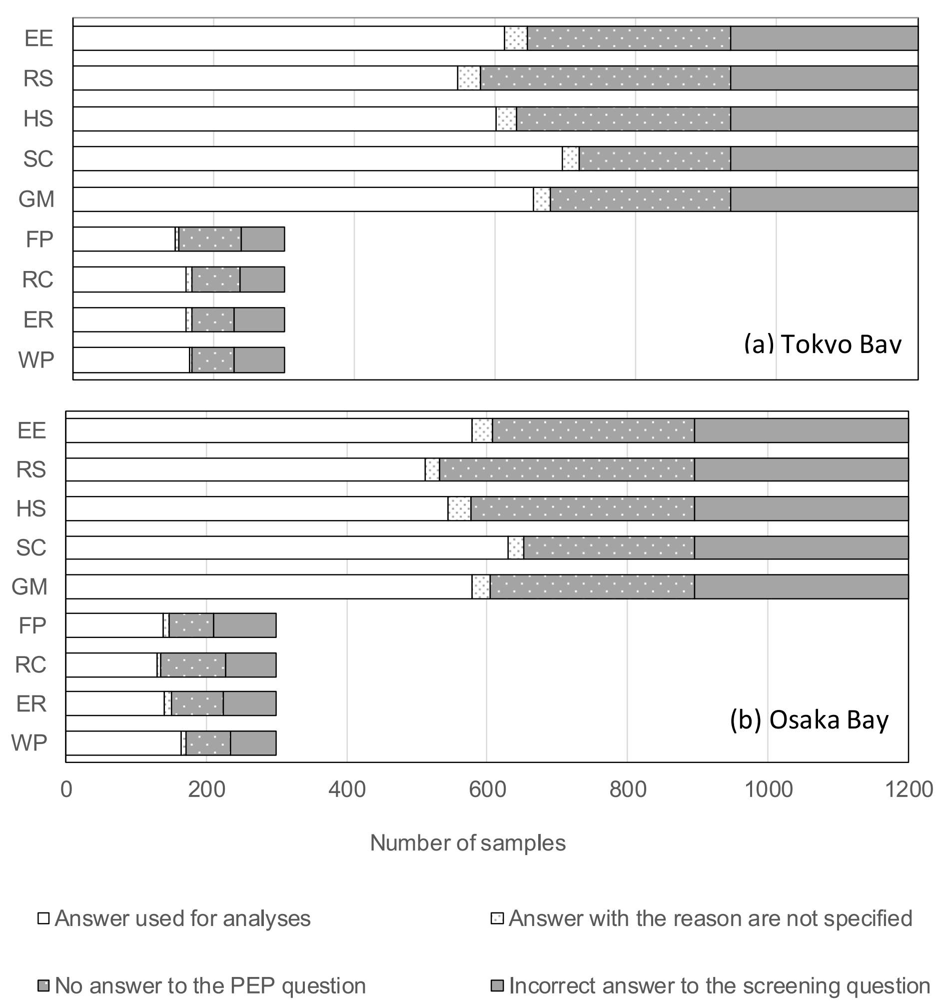


Fig. 3. Number of analysis samples after eliminating biased responses: (a) Tokyo Bay and (b) Osaka Bay. EE: Environmental education, RS: Research, HS: Historical site, SC: Species conservation, GM: Global warming mitigation, FP: Food provision, RC: Recreation, ER: Everyday relaxation, WP: Water purification.

questions for determining the value of PEP. The 'no-answer' responses comprised 18%–30% of total responses, which met the NOAA standard (Arrow et al., 1993).

Excluding these responses, the sample size used for the SE analysis ranged from 512 to 696; thus, the sample size target was met. The sample size used for the E-SS analysis was approximately 150 because only one E-SS was evaluated in each case. The power of the random utility model for each E-SS was greater than 90%. Thus, the sample size was judged to be sufficient for the analysis.

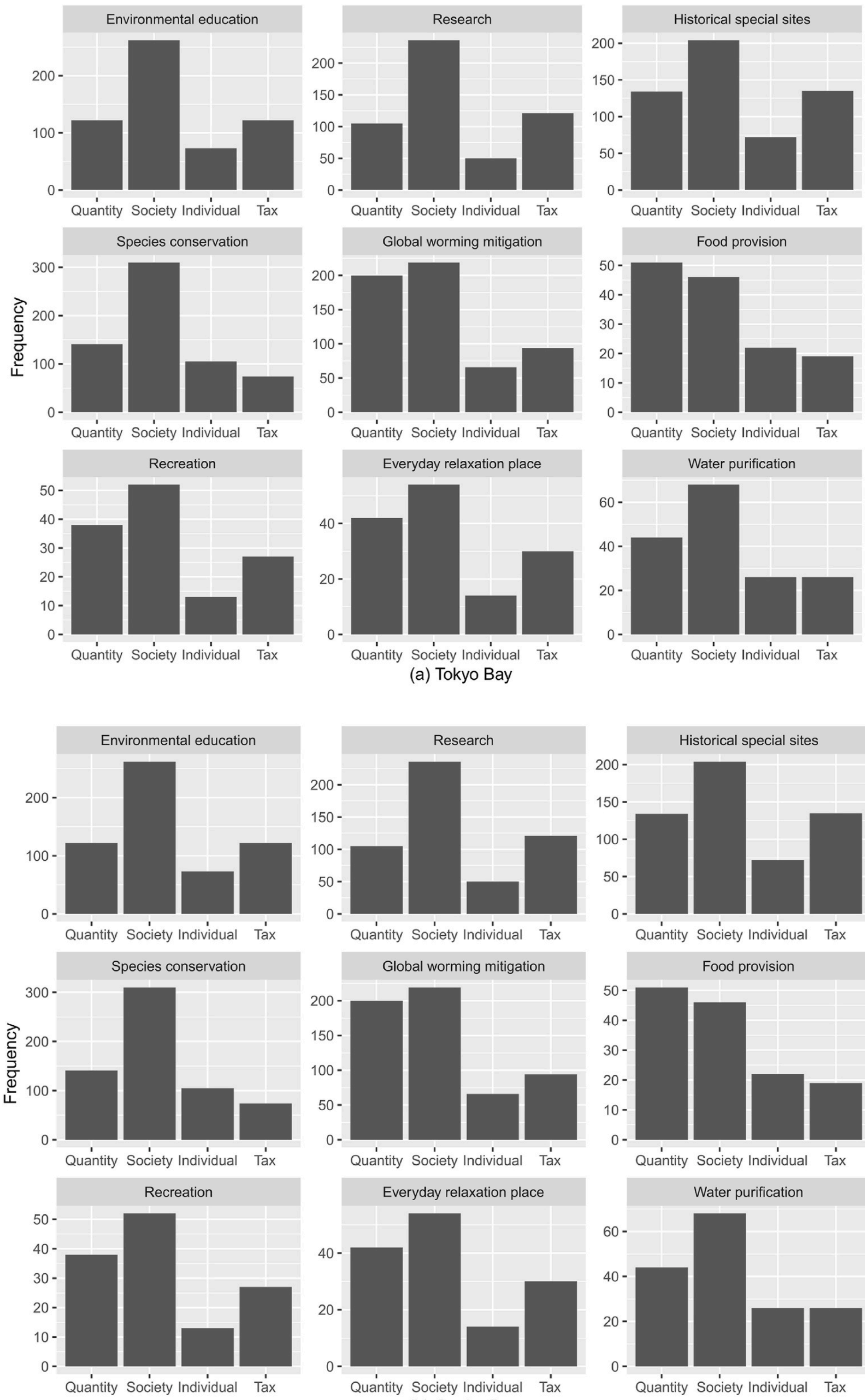


Fig. 4. Histogram of reasons for response: (a) Tokyo Bay and (b) Osaka Bay. Quantity, Society, Individual and Tax are the indicated reasons for the PEP response.

3.2. Reasons for PEP answer

In both the Tokyo Bay and Osaka Bay samples, the reason most frequently cited by respondents for their answer to the PEP questions was 'Society' for all services except food provision (18%–30% of analyzed responses; Fig. 4). For food provision, 'Quantity' was given most frequently as the reason, probably because the quantity relationship is easier to understand in the case of food provision than in cases involving any of the other services. Among those services for which 'Society' was selected most frequently as the reason, the second most frequently selected reason (except for historical site) was 'Quantity' (21%–37%), followed by 'Tax' (10%–26%) and 'Individual' (9%–21%).

3.3. Results of random utility model analysis

As an illustrative example, Table 4 shows the values of the coefficients $\beta_0, \beta_1, \beta_2, \beta_3, \ldots\beta_k$ from Eq. (4) estimated by the random utility model for species conservation. In both Tokyo Bay and Osaka Bay, no significant coefficient was obtained for the bid amount. In both bays, the most significant coefficient for species conservation was for 'reason for answer'. Among the reasons, the coefficient for 'Tax' was significant and negative, indicating a lower probability of accepting the bid. Note that the coefficient of 'Quantity' was assigned a value of 0 (making it the base case). Significant coefficients were also found for interest in environmental problem in both bays. Although there were significant coefficients for educational background in Tokyo Bay and annual income in Osaka Bay, no results were produced that could reasonably explain the distribution of coefficients. Moreover, no significant coefficient except for the everyday relaxation in Osaka Bay was observed for SS type, which suggests that SS type did not affect the value of PEP.

Similar features were also observed for the remaining eight services in both bay samples, with 'Tax' having a significant negative coefficient for all services. These results suggest that whether the value of the SE is judged to be higher than the bid does not depend on the bid amount or on individual attributes; rather, it strongly depends on the reason given for the respondent's answer. In addition, respondents who considered the appropriate expenditure of taxes tended to have a lower evaluation of the value of the services.

Table 4
Estimates of the coefficients of species conservation in Tokyo Bay and Osaka Bay.

Parameter	Tokyo Bay			Osaka Bay		
	Coefficient		Std. err.	Coefficient		Std. err.
β_0 Intercept	−1.33		1.55	−0.96		2.57
β_1 log(bid)	−0.14		0.10	−0.07		0.10
β_2 SS Everyday relaxation: Recreation	0.05		0.44	1.11	*	0.48
β_2 SS Food provision: Recreation	−0.32		0.42	0.58		0.40
β_2 SS Water purification: Recreation	−0.51		0.42	−0.11		0.41
β_3 Reason for answer Society: Quality	0.60		0.40	1.33	***	0.40
β_3 Reason for answer Individual: Quality	0.13		0.50	1.16	*	0.53
β_3 Reason for answer Tax: Quality	−2.29	***	0.42	−1.79	***	0.39
β_4 Interest in environmental problem	0.67	***	0.18	0.83	***	0.20
β_5 Knowledge of the marine environment	−0.03		0.07	−0.01		0.07
β_6 Age: 20s–30s: 10s	0.96		1.06	0.05		2.01
β_6 Age: 40s–50s: 10s	0.93		1.06	0.66		2.01
β_6 Age: 60s–80s: 10s	0.97		1.08	0.52		2.03
β_7 Sex female: male	0.09		0.33	0.19		0.34
β_8 Annual income (JPY[a]) 2 million ≤ x < 4 million: x < 2 million	−0.12		0.65	−0.05		0.70
β_8 Annual income (JPY): 4 million ≤ x < 6 million: x < 2 million	−0.25		0.60	−1.22	†	0.63
β_8 Annual income (JPY): 6 million ≤ x < 8 million: x < 2 million	−0.37		0.62	−0.56		0.68
β_8 Annual income (JPY): 8 million ≤ x < 10 million: x < 2 million	−0.60		0.65	−0.82		0.77
β_8 Annual income (JPY): 10 million ≤ x: x < 2 million	−0.22		0.64	−1.50	*	0.72
β_9 Education High school: Junior high school	1.86	†	1.01	−0.42		1.23
β_9 Education Technical college: Junior high school	2.58	*	1.24	−0.03		1.28
β_9 Education Junior college: Junior high school	0.69		1.05	0.89		1.38
β_9 Education College: Junior high school	1.54		0.96	−0.15		1.22
β_9 Education Graduate school: Junior high school	1.79		1.11	−0.23		1.34

† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.
[a] JPY: Japanese Yen; 100 JPY = 0.92 USD in January 2019.

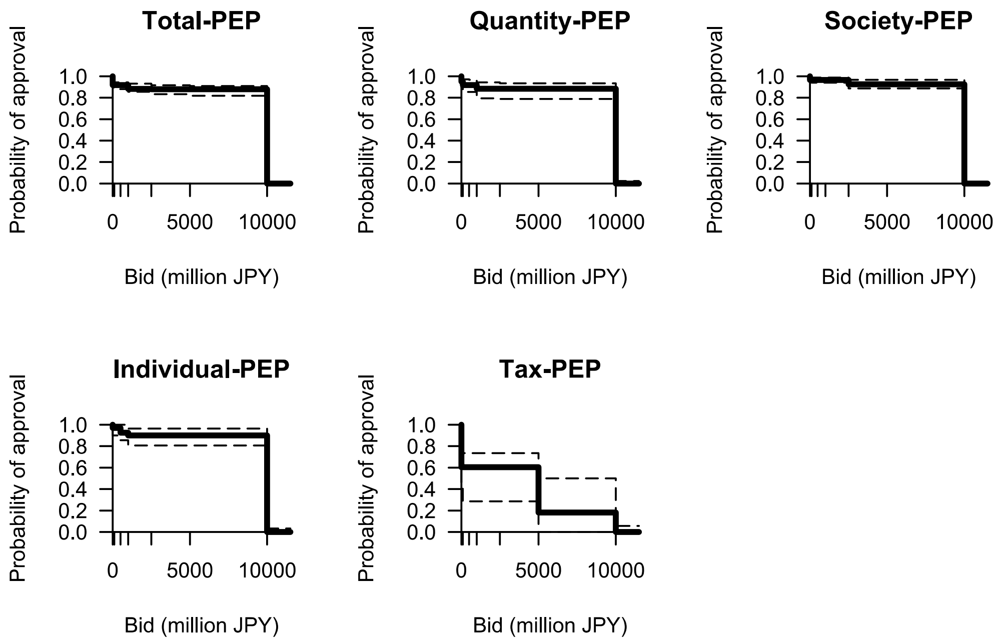
3.4. Calculation of PEP

Fig. 5 shows the curves for species conservation as a representative example of the survival curves of PEPs derived from nonparametric survival analysis. In both bays, Society-PEP, Individual-PEP, and Total-PEP had approval probabilities of 80%–90%, even at the highest bid level of 100 million JPY ha^{-1} year^{-1} (1 million USD ha^{-1} year^{-1}). Quantity-PEP had an approval probability of 70%–80% at the highest bid level. The approval probability of Tax-PEP gradually decreased with the bid amount, and the approval probability for the highest bid was only 18% in Tokyo Bay and 33% in Osaka Bay.

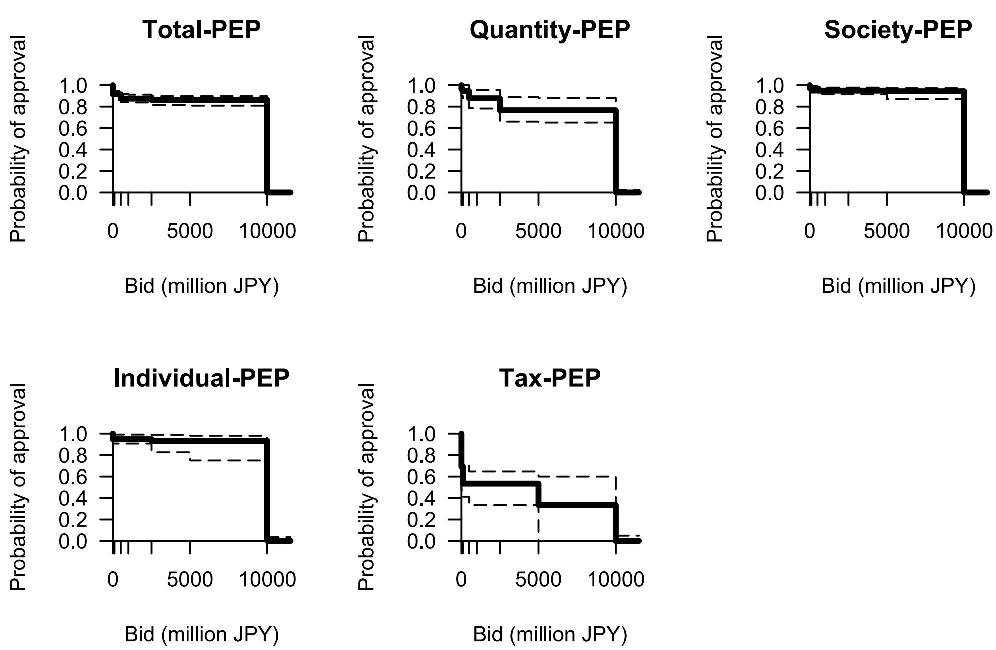
Table 5 shows the PEP for species conservation in each bay based on the survival curves in presented Fig. 5. In both bay samples, the Quantity-PEP, Society-PEP, and Individual-PEP respondents were not significantly different from Total-PEP with respect to the 95% confidence intervals. The average value was roughly 80–90 million JPY ha^{-1} year^{-1}, which is close to the highest bid value (100 million JPY ha^{-1} year^{-1}). The Tax-PEP was notably lower—39 million JPY ha^{-1} year^{-1} in Tokyo Bay and 43 million JPY ha^{-1} year^{-1} in Osaka Bay. The 95% confidence interval for Tax-PEP does not overlap with Total-PEP, Quantity-PEP, Society-PEP, or Individual-PEP, indicating the notable difference between Tax-PEP and the other PEPs.

Fig. 6 shows the mean Total-PEP and Tax-PEP values for all nine services. In the Tokyo Bay sample, the Total-PEP for species conservation was highest, followed in order by water purification, food provision, research, recreation, environmental education, global warming mitigation, everyday relaxation, and historical site. In the Osaka Bay sample, the order was species conservation, food provision, water purification, recreation, environmental education, global warming mitigation, research, historical site, and everyday relaxation. Although there were subtle differences in the rankings of services in the two bays, there was also some notable consistency: in both bays, species conservation, food provision, and water purification ranked in the top three, while historical site and everyday relaxation ranked in the bottom two. In addition, the difference in Total-PEP for the two bays was not significant for any of the services.

There were significant differences between the two bays in the case of Tax-PEP: food provision was higher in Osaka Bay, and recreation and everyday relaxation were higher in Tokyo Bay. The order of the service weights for Tax-PEP in Tokyo Bay was water purification, species conservation, global warming mitigation, research, recreation, environmental education, everyday relaxation, food provision, and historical site. The order of the service weights for the Tax-PEP in Osaka Bay was food provision, species conservation, water purification, global warming



(a) Tokyo Bay



(b) Osaka Bay

Fig. 5. Survival curves of PEP for species conservation in (a) Tokyo Bay and (b) Osaka Bay. Quantity-PEP, Society-PEP, Individual-PEP, and Tax-PEP designate the PEP results for respondents who gave the indicated reason for their PEP response. Total-PEP indicates the PEP of all respondents. JPY: Japanese Yen; 100 JPY = 0.92 USD in January 2019.

mitigation, research, environmental education, historical site, everyday relaxation, and recreation. In both bays, the Tax-PEP was lower than the Total-PEP for all services.

Table 6 compares the Total-PEPs and Tax-PEPs with the economic values determined by the revealed preference method for the four SSs. Except for recreation, the PEPs were all higher than the corresponding economic values determined by the revealed preference method. We also made between-bay comparisons of the various ratios (index quantity, economic value calculated by the revealed preference method, Total-PEP, and Tax-PEP) with respect to recreation, for which the difference in the index quantity was extremely high (4.25). The Tax-PEPs reflected the index quantity difference more closely than did the economic value calculated by the revealed preference method and the Total-PEPs. Thus, the Tax-PEP is considered to be superior to the Total-

Table 5
PEP calculation results (million JPY ha^{-1} $year^{-1}$). JPY: Japanese Yen; 100 JPY = 0.92 USD in January 2019.

	Tokyo Bay			Osaka Bay		
	Mean	95% Confidence interval		Mean	95% Confidence interval	
		Lower	Upper		Lower	Upper
Total-PEP	88	83	92	87	82	90
Quantity-PEP	89	80	94	80	69	90
Society-PEP	94	90	97	95	89	98
Individual-PEP	90	81	97	94	81	99
Tax-PEP	39	14	62	44	17	63

PEP in scope responsiveness.

3.5. Impact of norm awareness on PEP

In both bays, three factors were obtained via factor analysis (Table S2). In consideration of the factor loadings and the latent relationship with the norm activation model, the three factors were defined as awareness of responsibility (AR), awareness of problem (AP), and awareness of personal cost (APC). A higher factor score indicated a lower awareness for AP, whereas a higher factor score indicated a higher awareness for AR and APC.

Table 7 shows the results of an analysis of the effect of individual awareness of norms on the four reasons (Quantity, Society, Individual, and Tax) given for the respondent's PEP evaluation using a multinomial logit model. The reasons were treated as categorical variables. The coefficient of Quantity was assigned a value of 0 (making it the base case), so that only the Society, Individual, and Tax coefficients are shown in the table. In both bays, significant positive coefficients were observed for AP and APC in the Tax-PEP respondents, indicating.

that these respondents are less aware of environmental problems in coastal areas than the other respondents and that they have a higher cost awareness. This can be taken to mean that Tax-PEP respondents would be less inclined to overvalue services and more inclined to evaluate the

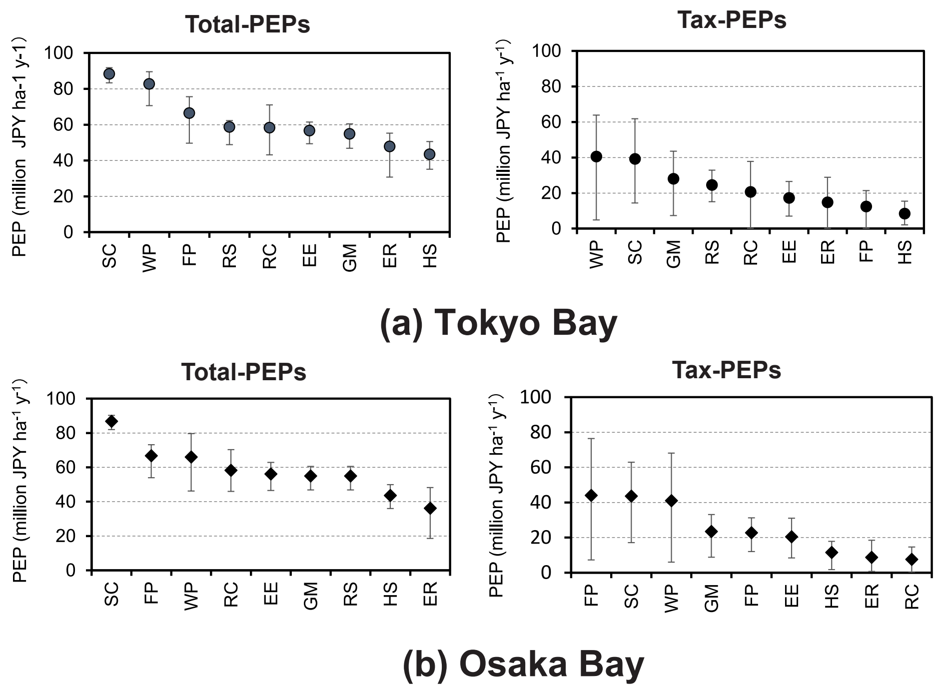


Fig. 6. Total-PEPs and Tax-PEPs for all nine services: (a) Tokyo Bay and (b) Osaka Bay. SC: Species conservation, WP: Water purification, FP: Food provision, RS: Research, RC: Recreation, EE: Environmental education, GM: Global warming mitigation, ER: Everyday relaxation, HS: Historical site. Mean PEP values estimated by the boot-strap method are shown; the error bars indicate the 95% confidence intervals. JPY: Japanese Yen; 100 JPY = 0.92 USD in January 2019.

Table 6
Comparison of Tax-PEP and economic value calculated by the revealed preference method (RP).

Service	Bay	Index quantity		Economic valuation by RP	Total-PEP	Tax-PEP
		Value	Unit	(million JPY[a] ha^{-1} $year^{-1}$)		
Food provision	Tokyo Bay	9	t ha^{-1} $year^{-1}$	4	66	13
	Osaka Bay	10	t ha^{-1} $year^{-1}$	5	67	44
	Tokyo/Osaka	0.90	–	0.73	1.00	0.28
Recreation	Tokyo Bay	34,000	visitors ha^{-1} $year^{-1}$	22	58	21
	Osaka Bay	8,000	visitors ha^{-1} $year^{-1}$	19	58	8
	Tokyo/Osaka	4.25	–	1.16	1.00	2.76
Everyday relaxation	Tokyo Bay	10,000	visitors ha^{-1} $year^{-1}$	10	48	15
	Osaka Bay	9,000	visitors ha^{-1} $year^{-1}$	4	36	9
	Tokyo/Osaka	1.11	–	2.50	1.33	1.72
Water purification	Tokyo Bay	7	t-COD ha^{-1} $year^{-1}$	12	83	41
	Osaka Bay	8	t-COD ha^{-1} $year^{-1}$	12	66	41
	Tokyo/Osaka	0.88	–	1.00	1.26	0.99

[a] JPY: Japanese Yen; 100 JPY = 0.92 USD in January 2019.

Table 7
Results of the analysis of the relationship between norm awareness and reason for PEP evaluation using the multinomial logit model. AR: awareness of responsibility, AP: awareness of problems, and APC: awareness of personal cost.

Parameter	Reason for answer	Tokyo Bay			Osaka Bay		
		Coefficient		Std. err.	Coefficient		Std. err.
Intercept	Society	0.56	***	0.04	0.46	***	0.04
	Individual	−0.74	***	0.06	−0.71	***	0.06
	Tax	−0.41	***	0.05	−0.32	***	0.05
AR	Society	−0.06		0.05	0.12	*	0.05
	Individual	0.04		0.07	0.08		0.06
	Tax	−0.02		0.06	−0.03		0.06
AP	Society	0.04		0.05	0.07		0.04
	Individual	0.02		0.07	0.11		0.06
	Tax	0.23	***	0.06	0.27	***	0.05
APC	Society	−0.28	***	0.05	−0.15	**	0.05
	Individual	−0.13	†	0.07	−0.09		0.07
	Tax	0.15	*	0.06	0.22	***	0.06

†$p < 0.1$; *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

appropriate PEP calmly and objectively.

The Society-PEP respondents had a significant negative coefficient for APC in both bays, meaning that these respondents were less aware of the cost of the NbS projects. The Society-PEP respondents had a significant positive coefficient for AR in Osaka Bay, indicating that these respondents had a higher awareness of their responsibility for the coastal environment in this bay. These results suggest that the Society-PEP respondents would tend to overestimate the value of the services.

The Individual-PEP respondents had no significant coefficients at the 5% significance level in either bay, indicating no significant difference in norm awareness between Individual-PEP and Quantity-PEP respondents.

3.6. Comparison of PEP and BWS

Fig. 7 shows the Total-PEP, Tax-PEP, and BWS scores for the services. In both bays, the rankings of the Total-PEP and BWS scores were in good agreement, whereas the rankings of the Tax-PEP and BWS scores showed little agreement. This difference is largely the result of the differences in Tax-PEP and Total-PEP relative to recreation in Osaka Bay and food provision in Tokyo Bay.

4. Discussion

4.1. Characteristics of the comparative evaluation method

As seen in the great impact that the Millennium Assessment has had globally, assessment and evaluation of ecosystems have become an increasingly important issue in recent decades. In the 2000s, the concept of ecosystem services began to be articulated in the global context (Gómez-Baggethun et al., 2010) based on the rich accumulation of economic/monetary evaluation methods. However, as seen in a following national ecosystem assessment in the United Kingdom, there is still room to explore and try different evaluation methods to bring social/shared values into the valuation discussion (Kenter et al., 2015) and overcome the trade-offs between cost-effectiveness and social equity (Norgaard, 2010).

We aimed to provide an alternative method of valuation. The proposed method has four main characteristics: 1) it focuses on the evaluation of public NbS projects as public works expenditures, 2) it uses the obtained PEP (permissible economic value of public works) as the respondent's tax allocation preference, 3) it utilizes relative comparisons of ecosystem services, and 4) it is produced from a single relatively low-cost questionnaire survey.

The most distinctive feature of the method is that it asks survey participants to evaluate public projects to improve the environment, rather than about the environment itself. In this way, we tried to remove the evaluation of the environment from a tourist's perspective, which was identified as one of the problems in monetary evaluations of ecosystem services (Berbés-Blázquez et al., 2016). We succeeded in capturing the benefits from the perspective of the local residents with a democratic and robust method. In recent years, there has been a focus on

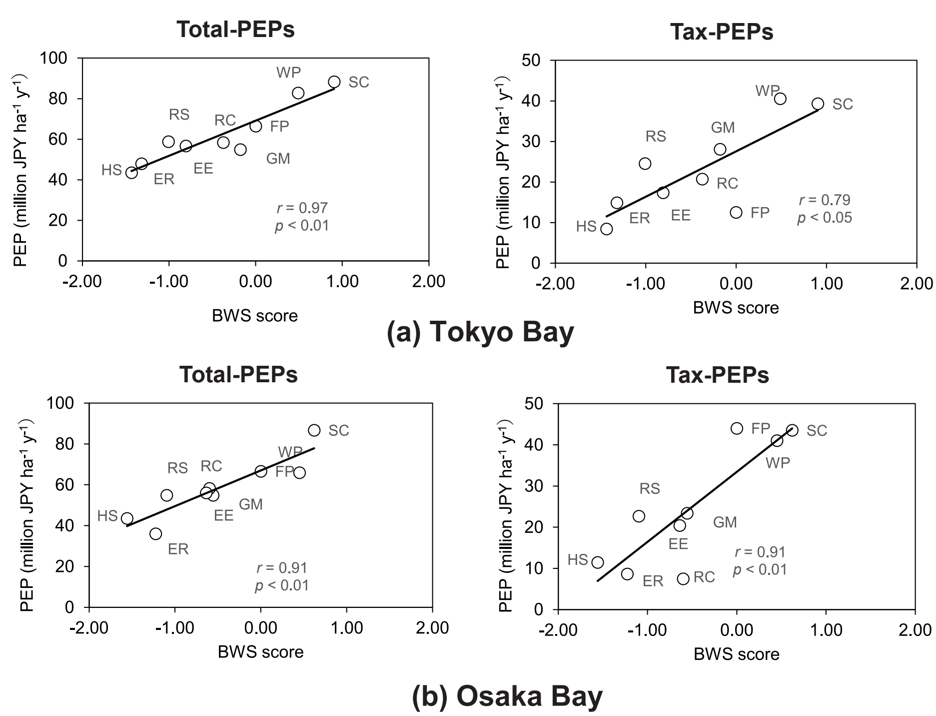


Fig. 7. Comparison of Total-PEPs and Tax-PEPs with BWS scores in (a) Tokyo Bay and (b) Osaka Bay. SC: Species conservation, WP: Water purification, FP: Food provision, GM: Global warming mitigation, RC: Recreation, EE: Environmental education, RS: Research, ER: Everyday relaxation, HS: Historical site. Mean PEP values estimated by the boot-strap method are shown. JPY: Japanese Yen; 100 JPY = 0.92 USD in January 2019.

decision support tools to put forth a transparent planning process for public projects (Evans and Klinger, 2008), encourage stakeholder participation (Ritchie and Ellis, 2010), and promote understanding of alternatives and trade-offs (Center for Ocean Solutions, 2011). The proposed method holds great promise for use as a decision support tool for public projects.

WTP has been shown to depend heavily on individual attributes such as annual income and age (Blackburn et al., 1994). In contrast, PEPs were not influenced by individual annual income, age, sex, or educational background (Table 4). Because our method is able to capture a respondent's tax allocation preference without being affected by the individual's annual income, PEP would appear to be a better index than WTP for evaluating public works, which are used by people with widely varying individual attributes. Furthermore, in CVM, economic value is typically calculated by multiplying mean WTP by the number of beneficiaries. Determining the number of beneficiaries is thus an important process that must be carefully considered. Our method avoids this challenge because PEP is normalized to area, not the number of beneficiaries.

With the proposed method, PEPs are produced based on relative comparisons of SSs (standard services) that are directly measurable and SEs (services to be evaluated) whose economic values are difficult to measure directly. By adopting a comparison, our method makes it possible to identify priorities for some regional context-specific values (e.g. Satoumi's concept of engendering relational values in addition to instrumental and intrinsic values; Uehara et al., 2019) that are difficult to measure directly. The community voice method (Ranger et al., 2016) and participatory mapping (Jones et al., 2020) are widely known methods of obtaining information about how stakeholders value the environment through the democratic process. However, it is very challenging to apply these methods when the target environment is multi-regional, used by a wide variety of beneficiaries, or both because these methods require intensive participation of stakeholders and cannot be scaled up for mass data collection. Therefore, as compared to these methods, our method is more suitable for use in multi-regional, large, natural ecosystems (e.g. a bay, river, or a mountain surrounded by several municipalities or countries) with a wide variety of beneficiaries.

A major benefit of PEPs is that they can be produced from a single questionnaire survey. Although the information obtained in a survey may be somewhat limited, one of the most significant advantages of our method is that democratic opinions can be reflected in the derived economic valuations with far less effort than they can be with other democratic decision-making approaches such as structured decision-making (Caceres-Escobar et al., 2019), multi-criteria analysis (Marshall et al., 2011), and the Deliberative Democratic Monetary Valuation method (Kenter et al., 2016). Past attempts to implement a democratic and robust methodology inevitably resulted in increased methodological complexity and a greater burden on the research participants, which can make implementation and interpretation by decision makers difficult (Marshall et al., 2011). In contrast, our method requires participants to complete a 30-min questionnaire survey that uses a comparative approach to reduce the burden on participants and researchers.

4.2. Validity of PEP

Total-PEPs correlated well with the BWS scores in both bays (Fig. 7). The results obtained in the Object Case BWS indicate the relative importance of the various services of tidal flats, and our method appears to produce relative assessments similar to those of the BWS. As shown in Fig. 5, however, the survival curve for the approval probability of Total-PEP did not decrease in proportion to increases in the bid amount. Thus, the evaluation of Total-PEP appears not to account for the quantity of the service.

In contrast to the Total-PEP, the survival curve for the Tax-PEP decreased as the bid amount increased (Fig. 5). Moreover, while the Total-PEP value did not reflect the huge difference in recreation quantity between the two bays, the Tax-PEP effectively mirrored this major quantity difference (Table 6). This result suggests that the Tax-PEP values are appropriately sensitive to scope. In contrast, CVM is rather insensitive to scope, which means it is very difficult to produce WTP values that properly reflect increases or decreases in quantity (Desvousges et al., 2012). Tax-PEP effectively avoids this deficiency.

One possible reason for CVM's insensitivity to scope is the existence of the warm-glow effect (Wg) (Arrow et al., 1993). This effect represents the satisfaction that a person experiences from doing good deeds and can cause disproportionate enthusiasm and support for socially positive causes such as solving environmental problems. Nunes and Schokkaert (2003) report that by quantifying the intensity of a person's Wg on a psychological scale, Wg effects can be removed, resulting in generally lower WTP values that respond more appropriately to scope. We believe that one of the reasons Tax-PEP shows good scope sensitivity is because the influence of Wg has been removed. This is supported by the fact that Tax-PEP respondents did not have excessively high expectations for the environment (Table 7), making the effect of Wg on Tax-PEP rather weak. Tax-PEP respondents accounted for only 10%–20% of all survey respondents (Fig. 3), which indicates a problem with the representativeness of the responses. However, considering that it is more reasonable to assume the lowest acceptable value of public works, we decided to use the Tax-PEP as the primary PEP in our method. In the ensuing discussion, Tax-PEP is considered the PEP.

We compared the economic value determined by the revealed preference method and the PEPs for the SSs (food provision, water purification, everyday relaxation, and recreation) for which both measures were calculated (Tax-PEP in Table 6). For food provision, water purification, and everyday relaxation, the PEP yielded the larger value. This can be explained by the fact that the economic value calculated by the revealed preference method evaluates only the use value of the service, whereas PEP responds to quantity and includes non-use value. For example, in the case of food provision, local fish catches have value not only as food but also as a cultural symbol. We presume that the inclusion of non-use value in the PEP is what produces a PEP that is greater than the economic value determined by the revealed preference method. We also found that the PEP for food provision was higher in Osaka Bay than in Tokyo Bay, which would seem to indicate that the residents of Osaka Bay place a greater value on the non-use benefits of food provision than do the residents of Tokyo Bay. As for water purification, we consider that the existence value (i.e. the non-use value) of clean seawater is high in Tokyo Bay and Osaka Bay because water quality deterioration has become a serious social issue (Furukawa and Okada, 2006). Moreover, we presume that the non-use value of everyday relaxation is high because everyday relaxation provides mental and emotional satisfaction in our daily lives.

With respect to recreation, the economic value determined by the revealed preference method was higher than the PEP (Tax-PEP in Table 6). This suggests that people may not readily recognize the non-use value of recreation in tidal flats. Furthermore, for people living in major cities like Tokyo and Osaka, the PEP may have been evaluated lower than the economic value because many places are available for recreation besides the tidal flats.

Thus, the PEPs of the SSs do not necessarily agree with the economic values determined by the revealed preference method. Whether the PEP or the more directly calculated economic value should be used as the preferred measure of the economic value of an SS is unclear when calculating the comprehensive ecosystem services of tidal flats. However, if non-use value is applicable to all services, it would seem acceptable to use the PEP as an appropriate measure of the economic value of the SSs.

4.3. Application to NbS projects

The cross-sector character of the impacts to be addressed in the assessment of NbS means that a range of different quantitative and qualitative indicators needs to be considered (Raymond et al., 2017). Our method is an assessment framework of NbS projects because it compares different quantitative and qualitative services and evaluates them with a common index (i.e. a monetary unit). The method determines the value of public works, such as NbS projects, and assigns relative weights to their various services. By using this method of evaluation, authorities can assess the co-benefits of NbS projects from the perspective of the local residents, allowing for more balanced planning and management. In addition, the assessment results can serve as a powerful essential communication tool with stakeholders about trade-offs across services. Moreover, PEP estimates the benefits to society assessed from a public works viewpoint and is expected to provide strong support to decision makers in the implementation of NbS projects.

Although we studied tidal-flat ecosystems, our method can be applied to other aquatic, coastal, and terrestrial ecosystems as well. Of course, the specific services of each ecosystem would need to be considered, but the framework of this comparative evaluation method can be applied to evaluate these ecosystem services in a regional context from the perspective of the priorities of the local residents. However, it is presumed that the relative weights assigned to services differ depending on the scope of the questionnaire. It is therefore necessary to carefully consider the range of people that should be reflected in the valuation before conducting the assessment.

5. Conclusion

In this study, a novel stated preference method was developed to evaluate the various ecosystem services (food provision, water purification, recreation, etc.) of NbS projects from the viewpoint of public works. In this approach, a permissible economic value of environmental public works (PEP) is produced as a measure of the public works cost that citizens would be willing to accept for a project or service. Our method is generally comparable to BWS for assessing services and is capable of producing PEPs that are quantity sensitive. Our method controls for the warm-glow effect to reduce overestimation of the values of services and weakens the influences of individual respondent characteristics on the value estimates. On the basis of these features, we conclude that it appears to be an effective and efficient method for determining the value of public works, such as NbS projects, and assigning relative weights to the various services.

In the future, we plan to integrate the method with ecosystem services scoring methods (Okada et al., 2019) associated with social and ecological indicators and to develop an ecosystem services evaluation method useful for planning and managing NbS projects.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Yugo Mito is employed by Fukken Co., Ltd.

Acknowledgements

This work was funded by the Ministry of Land, Infrastructure, Transport and Tourism in Japan. The authors acknowledge and thank the Ministry for its support of this work, both financial and in providing data. This work was supported in part by Grants-in-Aid (JSPS KAKENHI, no. 18H04156). We also thank the Ministry of the Environment, Japan Coast Guard, Tokyo Metropolitan Government, Chiba Prefecture Government, City of Yokohama, Osaka City, Amagasaki City, Chiba Prefecture Fisheries Research Center, Yokohama Greenery Foundation, Nankou Wetland Conservation Group, Osaka Museum of Natural History, nature Osaka, Ota Fisheries Cooperative, Kawasaki River Fisheries Cooperative, and Osaka-city Fishermen's Cooperative Association for help in data collection.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ocecoaman.2021.105848.

Ethics approval

This research was conducted using the web survey system by Rakuten Insight, Inc., a member of Japan Marketing Research Association and complies with the ICC/ESOMAR International Code (http://www.jmra-net.or.jp/Portals/0/rule/ICCESOMAR_Code_English_December2016.pdf), under ethics approval from National Institute for Land and Infrastructure Management (Y-1754). All participants taking the participatory questionnaire were informed of the methods and ethical considerations (https://member.insight.rakuten.co.jp/explanation/privacy/) before signing a Consent Form.

Authors' contributions

T.O., Y.M., and T.K. conceived and designed the experiments. T.O. and Y.M. performed the experiments. K.T., H.S., T.K., Y.B.A, T.E., S.O., S. Y., T.K., T.K., K.O., R.Y., and T.S. analyzed the data and made significant contributions to the development of the concepts. T.O. and Y.M. prepared the figures and tables. T.O. Y.M., and T.K. drafted the work or revised it critically for important content. All authors contributed to the drafts and gave final approval for publication.

References

Agimass, F., Mekonnen, A., 2011. Low-income fishermen's willingness-to-pay for fisheries and watershed management: an application of choice experiment to Lake Tana, Ethiopia. Ecol. Econ. 71, 162–170. https://doi.org/10.1016/j.ecolecon.2011.08.025.

Aizaki, H., 2015. support.BWS: Basic Functions for Supporting an Implementation of Best-Worst Scaling. https://CRAN.R-project.org/package=support.BWS/. (Accessed 6 October 2020).

Arias-Arévalo, P., Martín-López, B., Gómez-Baggethun, E., 2017. Exploring intrinsic, instrumental, and relational values for sustainable management of social-ecological systems. Ecol. Soc. 22 (4), art43. https://doi.org/10.5751/ES-09812-220443.

Arrow, K., Solow, R., Portney, P.R., Leamer, E.E., Radner, R., Schuman, H., 1993. Report of the NOAA panel on contingent valuation. Fed. Regist. 58, 4601–4614. https://doi.org/10.1258/095646202760029804.

Barbier, E.B., 2012. Progress and challenges in valuing coastal and marine ecosystem services. Rev. Environ. Econ. Pol. 6 (1), 1–19. https://doi.org/10.1093/reep/rer017.

Berbés-Blázquez, M., González, J.A., Pascual, U., 2016. Towards an ecosystem services approach that addresses social power relations. Curr. Opin. Environ. Sustain. 19, 134–143. https://doi.org/10.1016/j.cosust.2016.02.003.

Blackburn, M., Harrison, G.W., Rutstrom, E.E., 1994. Statistical bias functions and informative hypothetical surveys. Am. J. Agric. Econ. 76 (5), 1084–1088. https://doi.org/10.2307/1243396.

Blamey, R., 1998. Contingent valuation and the activation of environmental norms. Ecol. Econ. 24, 47–72. https://doi.org/10.1016/S0921-8009(97)00586-7.

Borger, T., Hattam, C., 2017. Motivations matter: behavioural determinants of preferences for remote and unfamiliar environmental goods. Ecol. Econ. 131, 64–74. https://doi.org/10.1016/j.ecolecon.2016.08.021.

Braat, L.C., de Groot, R., 2012. The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy. Ecosys. Services 1 (1), 4–15. https://doi.org/10.1016/j.ecoser.2012.07.011.

Bullock, J.M., Aronson, J., Newton, A.C., Pywell, R.F., Rey-Benayas, J.M., 2011. Restoration of ecosystem services and biodiversity: conflicts and opportunities. Trends Ecol. Evol. 26, 541–549. https://doi.org/10.1016/j.tree.2011.06.011.

Caceres-Escobar, H., Kark, S., Atkinson, S.C., Possingham, H.P., Davis, K.J., 2019. Integrating local knowledge to prioritise invasive species management. People Nat. 1, 220–233. https://doi.org/10.1002/pan3.27.

Carson, R.T., 2012. Contingent valuation: a practical alternative when prices aren't available. J. Econ. Perspect. 26 (4), 27–42. https://doi.org/10.1257/jep.26.4.27.

Center for Ocean Solutions, 2011. Decision guide: selecting decision support tools for marine spatial planning. The Woods Institute for the Environment, Stanford University, California. https://www.openchannels.org/sites/default/files/webinar

s/Decision%20Guide%20Selecting%20decision%20support%20tools%20for%20MSP.pdf/. (Accessed 23 June 2021).
Champ, A., Boyle, K.J., Brown, T.C., 2017. A primer on nonmarket valuation patricia. In: The Economics of Non-market Goods and Resources, vol. 13. Springer, Dordrecht. https://doi.org/10.1007/978-94-007-7104-8.
Chan, K.M.A., Balvanera, P., Benessaiah, K., Chapman, M., Díaz, S., Gómez-Baggethun, E., Gould, R., Hannahs, N., Jax, K., Klain, S., Luck, G.W., Martín-López, B., Muraca, B., Norton, B., Ott, K., Pascual, U., Satterfield, T., Tadaki, M., Taggart, J., Turner, N., 2016. Opinion: why protect nature? Rethinking values and the environment. Proc. Natl. Acad. Sci. Unit. States Am. 113 (6), 1462–1465. https://doi.org/10.1073/pnas.1525002113.
Chan, K.M., Gould, R.K., Pascual, U., 2018. Editorial overview: relational values: what are they, and what's the fuss about? Curr. Opin. Environ. Sustain. 35 (A1–A7) https://doi.org/10.1016/j.cosust.2018.11.003.
Costanza, R., Arge, R., de Groot, R., Farberk, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Suttonkk, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. Nature 387, 253–260. https://doi.org/10.1038/387253a0.
Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S., Turner, R.K., 2014. Changes in the global value of ecosystem services. Global Environ. Change 26, 152–158. https://doi.org/10.1016/j.gloenvcha.2014.04.002.
Croissant, Y., 2010. Mlogit: Multinomial Logit Models. https://cran.r-project.org/web/packages/mlogit/. (Accessed 6 October 2020).
De Groot, J.I.M., Steg, L., 2009. Morality and prosocial behavior: the role of awareness, responsibility, and norms in the norm activation model. J. Soc. Psychol. 149, 425–449. https://doi.org/10.3200/SOCP.149.4.425-449.
de Groot, R., Brander, L., van der Ploeg, S., Costanza, R., Bernard, F., Braat, L., Christie, M., Crossman, N., Ghermandi, A., Hein, L., Hussain, S., Kumar, P., McVittie, A., Portela, R., Rodriguez, L.C., ten Brink, P., van Beukering, P., 2012. Global estimates of the value of ecosystems and their services in monetary units. Ecosys. Services 1, 50–61. https://doi.org/10.1016/j.ecoser.2012.07.005.
Desvousges, W., Mathews, K., Train, K., 2012. Adequate responsiveness to scope in contingent valuation. Ecol. Econ. 84, 121–128. https://doi.org/10.1016/j.ecolecon.2012.10.003.
Duarte, C.M., Agusti, S., Barbier, E., Britten, G.L., Castilla, J.C., Gattuso, J.P., Robinson, W., Fulweiler, R.W., Hughes, T.P., Knowlton, N., Lovelock, C.E., Lotze, H. K., Predragovic, M., Poloczanska, E., Roberts, C., Worm, B., 2020. Rebuilding marine life. Nature 580, 39–51. https://doi.org/10.1038/s41586-020-2146-7.
Elliott, M., Burdon, D., Hemingway, K.L., Apitz, S.E., 2007. Estuarine, coastal and marine ecosystem restoration: confusing management and science - a revision of concepts. Estuarine. Coast. Shelf Sci. 74, 349–366. https://doi.org/10.1016/j.ecss.2007.05.034.
Evans, K.E., Klinger, T., 2008. Obstacles to bottom-up implementation of marine ecosystem management. Conserv. Biol. 22 (5), 1135–1143. https://doi.org/10.1111/j.1523-1739.2008.01056.x.
Freeman III, A.M., Herriges, J.A., Kling, C.L., 2014. The Measurement of Environmental and Resource Values: Theory and Methods. Routledge.
Furukawa, K., 2013. Case studies for urban wetlands restoration and management in Japan. Ocean Coast Manag. 81, 97–102. https://doi.org/10.1016/j.ocecoaman.2012.07.012.
Furukawa, K., Okada, T., 2006. Tokyo Bay: its environmental status - past, present and future -. In: Wolanski, E. (Ed.), The Environment in Asia Pacific Harbors. Springer Netherlands, pp. 15–34.
Furukawa, K., Atsumi, M., Okada, T., 2019. Tokyo Bay: importance of citizen science application for integrated coastal management - change of Gobies' survival strategies in Tokyo Bay, Japan. Estuarine. Coast. Shelf Sci. 228, 106388 https://doi.org/10.1016/j.ecss.2019.106388.
García-Onetti, J., Scherer, M.E.G., Barragan, J.M., 2018. Integrated and ecosystemic approaches for bridging the gap between environmental management and port management. J. Environ. Manag. 206, 615–624. https://doi.org/10.1016/j.jenvman.2017.11.004.
Gómez-Baggethun, E., de Groot, R., Lomas, P.L., Montes, C., 2010. The history of ecosystem services in economic theory and practice: from early notions to markets and payment schemes. Ecol. Econ. 69, 1209–1218. https://doi.org/10.1016/j.ecolecon.2009.11.007.
Grubert, E., 2018. Relational values in environmental assessment: the social context of environmental impact. Curr. Opin. Environ. Sustain. 35, 100–107. https://doi.org/10.1016/j.cosust.2018.10.020.
Hanemann, W.M., Kanninen, B., 1996. The statistical analysis of discrete-response cv data. In: CUDARE Working Papers 25022, University of California. Department of Agricultural and Resource Economics, Berkeley. https://doi.org/10.22004/ag.econ.25022.
Hanley, N., Wright, R.E., Adamowicz, V., 1998. Using choice experiments to value the environment. Environ. Resour. Econ. 11, 413–428. https://doi.org/10.1023/A:1008287310583.
IUCN (International Union for Conservation of Nature), 2016. Resolution 69 on defining nature-based solutions (WCC-2016-Res-069). https://portals.iucn.org/library/sites/library/files/resrecfiles/WCC_2016_RES_069_EN.pdf. (Accessed 23 June 2021).
Jones, L., Holland, R.A., Ball, J., Sykes, T., Taylor, G., Lisa Ingwall-King, L., Snaddon, J. L., Peh, K.S.H., 2020. A place-based participatory mapping approach for assessing cultural ecosystem services in urban green space. People Nat. 2, 123–137. https://doi.org/10.1002/pan3.10057.
Kenter, J.O., O'Brien, L., Hockley, N., Ravenscroft, N., Fazey, I., Irvine, K.N., Reed, M.S., Christie, M., Brady, E., Bryce, R., Church, A., Cooper, N., Davies, A., Evely, A., Everard, M., Fish, R., Fisher, J.A., Jobstvogt, N., Molloy, C., Orchard-Webb, J., Ranger, S., Ryan, M., Watson, V., Williams, S., 2015. What are shared and social values of ecosystems? Ecol. Econ. 111, 86–99. https://doi.org/10.1016/j.ecolecon.2015.01.006.
Kenter, J.O., Bryce, R., Christie, M., Cooper, N., Hockley, N., Irvine, K.N., Fazey, I., O'Brien, L., Orchard-Webb, J., Ravenscroft, N., Raymond, C.M., Reed, M.S., Tett, P., Watson, V., 2016. Shared values and deliberative valuation: future directions. Ecosys. Services 21, 358–371. https://doi.org/10.1016/j.ecoser.2016.10.006.
Kim, J., Lim, S.Y., Yoo, S.H., 2017. Public willingness to pay for restoring destroyed tidal flats and utilizing them as ecological resources in Korea. Ocean Coast Manag. 142, 143–149.
Kling, C.L., Phaneuf, D.J., Zhao, J., 2012. From Exxon to BP: has some number become better than no number? J. Econ. Perspect. 3–26.
Kuwae, T., Crooks, S., 2021. Linking climate change mitigation and adaptation through coastal green–gray infrastructure: a perspective. Coast Eng. J. https://doi.org/10.1080/21664250.2021.1935581.
Lo, A.Y., Spash, C.L., 2012. Deliberative monetary valuation: in search of a democratic and value plural approach to environmental policy. J. Econ. Surv. 27, 768–789. https://doi.org/10.1111/j.1467-6419.2011.00718.x.
Louviere, J.J., Flynn, T.N., Marley, A.A.J., 2015. Best-Worst Scaling: Theory, Methods and Applications. Cambridge University Press, Marley.
Marshall, G.R., McNeill, J.M., Reeve, I.J., 2011. Economics for Accountability in Community-Based Environmental Governance. Institute for Rural Futures, University of New England, Armidale. https://www.une.edu.au/_data/assets/pdf_file/0003/16383/2011-ECONOMICS-FOR-ACCOUNTABILITY-IN-COMMUNITY-BASED-ENVIRONMENTAL-GOVERNANCE.pdf/. (Accessed 6 October 2020).
McLeod, E., Chmura, G.L., Bouillon, S., Salm, R., Björk, M., Duarte, C.M., Lovelock, C.E., Schlesinger, W.H., Silliman, B.R., 2011. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO_2. Front. Ecol. Environ. 9, 552–560. https://doi.org/10.1890/110004.
Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-Being Synthesis. Island Press, Washington, DC.
Mito, Y., Noguchi, T., Onodera, K., Mizokawa, S., Oonishi, K., Okada, T., 2021. Ecosystem functions of confined-scale artificial tidal flats in urban areas in Japan: analysis of driving factors for function-based design. Coast Eng. J. https://doi.org/10.1080/21664250.2021.1923287.
Nakatani, T., Aizaki, H., Sato, K., 2016. DCchoice: Analyzing Dichotomous Choice Contingent Valuation Data. https://cran.r-project.org/web/packages/DCchoice/DCchoice.pdf/. (Accessed 6 October 2020).
Neilson, W., Wichmann, B., 2014. Social networks and non-market valuations. J. Environ. Econ. Manag. 67 (2), 155–170.
Norgaard, R.B., 2010. Ecosystem services: from eye-opening metaphor to complexity blinder. Ecol. Econ. 69 (6), 1219–1227. https://doi.org/10.1016/j.ecolecon.2009.11.009.
Nunes, P.A.L.D., Schokkaert, E., 2003. Identifying the warm glow effect in contingent valuation. J. Environ. Econ. Manag. 45, 231–245. https://doi.org/10.1016/S0095-0696(02)00051-7.
Okada, T., Mito, Y., Iseri, E., Takahashi, T., Sugano, T., Akiyama, Y.B., Watanabe, K., Tanaya, T., Sugino, H., Tokunaga, K., Kubo, T., Kuwae, T., 2019. Method for the quantitative evaluation of ecosystem services in coastal regions. PeerJ 6, e6234. https://doi.org/10.7717/peerj.6234.
Okada, T., Mito, Y., Akiyama, Y.B., Tokunaga, K., Sugino, H., Kubo, T., Endo, T., Otani, S., Yamochi, S., Kozuki, Y., Kusakabe, T., Otsuka, K., Yamanaka, R., Shigematsu, T., Kuwae, T., 2021. Green port structures and their ecosystem services in highly urbanized Japanese bays. Coast Eng. J. https://doi.org/10.1080/21664250.2021.1911194.
Orchard-Webb, J., Kenter, J.O., Bryce, R., Church, A., 2016. Deliberative democratic monetary valuation to implement the ecosystem Approach. Ecosys. Services 21. https://doi.org/10.1016/j.ecoser.2016.09.005.
O'Connor, E., Hynes, S., Chen, W., 2020. Estimating the non-market benefit value of deep-sea ecosystem restoration: evidence from a contingent valuation study of the Dohrn Canyon in the Bay of Naples. J. Environ. Manag. 275, 111180 https://doi.org/10.1016/j.jenvman.2020.111180.
PIANC Working Group 176, 2018. Guide for applying working with nature to navigation infrastructure projects. PIANC EnviCom WG Report 176.
Ranger, S., Kenter, J.O., Bryce, R., Cumming, G., Dapling, T., Lawes, E., Richardson, P.B., 2016. Forming shared values in conservation management: an interpretive-deliberative-democratic approach to including community voices. Ecosys. Services 21, 344–357. https://doi.org/10.1016/j.ecoser.2016.09.016.
Raymond, C.M., Berry, P., Breil, M., Nita, M.R., Kabisch, N., de Bel, M., Enzi, V., Frantzeskaki, N., Geneletti, D., Cardinaletti, M., Lovinger, L., Basnou, C., Monteiro, A., Robrecht, H., Sgrigna, G., Munari, L., Calfapietra, C., 2017. An impact evaluation framework to support planning and evaluation of Nature-based Solutions projects. In: Report Prepared by the EKLIPSE Expert Working Group on Nature-Based Solutions to Promote Climate Resilience in Urban Areas. Centre for Ecology & Hydrology, Wallingford, United Kingdom.
Reguero, B.G., Beck, M.W., Agostini, V.N., Kramer, P., Hancock, B., 2018. Coral reefs for coastal protection: a new methodological approach and engineering case study in Grenada. J. Environ. Manag. 210, 146–161. https://doi.org/10.1016/j.jenvman.2018.01.024.
Revelle, W., 2018. Psych: Procedures for Psychological, Psychometric, and Personality Research. https://personality-project.org/r/psych/. (Accessed 26 December 2019).
Ritchie, H., Ellis, G., 2010. 'A system that works for the sea'? Exploring stakeholder engagement in marine spatial planning. J. Environ. Plann. Manag. 53 (6), 701–723. https://doi.org/10.1080/09640568.2010.488100.

Sarrias, M., Daziano, R., Sato, K., Croissant, Y., 2018. Gmnl: Multinomial Logit Models with Random Parameters. https://cran.r-project.org/web/packages/gmnl/gmnl.pdf/. (Accessed 6 October 2020).

Schlacher, T.A., Schoeman, D.S., Jones, A.R., Dugan, J.E., Hubbard, D.M., Defeo, O., Peterson, C.H., Weston, M.A., Maslo, B., Olds, A.D., Scapini, F., Nel, R., Harris, L.R., Lucrezi, S., Lastra, M., Huijbers, C.M., Connolly, R.M., 2014. Metrics to assess ecological condition, change, and impacts in sandy beach ecosystems. J. Environ. Manag. 144, 322–335. https://doi.org/10.1016/j.jenvman.2014.05.036.

Schwartz, S.H., 1977. Normative influences on altruism. Adv. Exp. Soc. Psychol. 10, 221–279. https://doi.org/10.1016/S0065-2601(08)60358-5.

TEEB, 2010. In: Kumar, P. (Ed.), The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Earthscan, London and Washington.

Tokunaga, K., Sugino, H., Nomura, H., Michida, Y., 2019. Norms and the willingness to pay for coastal ecosystem restoration: a case of the Tokyo Bay intertidal flats. Ecol. Econ. 166 https://doi.org/10.1016/j.ecolecon.2019.106423.

Turnbull, B.W., 1974. Nonparametric estimation of a survivorship function with doubly censored data. J. Am. Stat. Assoc. 69, 169–173. https://doi.org/10.1080/01621459.1974.10480146.

Tyner, E.H., Boyer, T.A., 2020. Applying best-worst scaling to rank ecosystem and economic benefits of restoration and conservation in the Great Lakes. J. Environ. Manag. 255, 109888. https://doi.org/10.1016/j.jenvman.2019.109888.

Uehara, T., Hidaka, T., Matsuda, O., Sakurai, R., Yanagi, T., Yoshioka, T., 2019. Satoumi: Re-connecting people to nature for sustainable use and conservation of coastal zones. People Nat. 1, 435–441. https://doi.org/10.1002/pan3.10047.

Wang, X., Chen, W., Zhang, L., Jin, D., Lu, C., 2010. Estimating the ecosystem service losses from proposed land reclamation projects: a case study in Xiamen. Ecol. Econ. 69, 2549–2556. https://doi.org/10.1016/j.ecolecon.2010.07.031.