

Article

Incorporating Integrative Perspectives into Impact Reduction Management in a Reef Recreation Area

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Abstract: The act of balancing two sustainability goals, the conservation of ecosystem services, and allowing access to reef recreational areas is a big challenge for the management of marine protected areas (MPAs). This study evaluates tourist preferences towards integrative aspects of an impact reduction program in a reef recreation area. We find that by integrating the marine police institution, providing educational training, setting up control of the number of divers, setting up control of the experience area, and taking boats to the snorkeling point are the key factors. We also identify the features that affect the heterogeneity of preferences with impact reduction management in the MPAs as follows: (1) monthly income; (2) type of tourist; and (3) joining conservation groups, and the integrated program generate the highest welfare value. These results can be applied to create a suitable management strategy for sustainable reef tourism that meets the needs of stakeholders.

Keywords: ecosystem-based management; reef conservation foundation; market segmentation; impact reduction program; willingness to pay

1. Introduction

In tropical and subtropical regions, coral reefs function as fisheries and biomedicine repositories, provide coastal protection, and provide ecosystem services. These services involve both extractive and non-extractive activities, which support social development and human well-being [1]. Coral reefs benefit more than 0.5 billion people in approximately one hundred countries around the world [2–4]. Furthermore, many small island countries are heavily reliant on the range of ecosystem services provided by stable coral reefs for the sustainable development of their societies [5]. Besides the impact of climate change, many coral reef ecosystems are imperiled by the damage caused by unsustainable tourism practices and human impacts. Boat anchoring [6], snorkeling [7,8], and trampling [9] harm popular reef diving or snorkeling areas [10–12]. Divers and snorkelers kicking with fins, physical breakage through contact (i.e., individuals kneeling, sitting, grasping, or standing on coral), and their equipment brushing against coral [11–14] can significantly lower the ecological sustainability of a reef's ecosystem [4].

From a policy-making standpoint, management strategies for reef tourism should integrate the perspectives of economics, culture, and institutional consequences (such as management strategy, target segmentation) [15,16]. The above-mentioned human impacts on coral reefs may be conceptualized as falling within the rubric of institutional (such as “control the number of divers” and “marine police

mechanism”) and recreational (such as “the way to the snorkeling point” and “educational training”) perspectives on sustainable marine tourism [17–19] and as matters directly related to the effectiveness of reef management by decision-makers [20]. Grafeld et al. [3] indicated that the managers of coral reefs need information and evidence that is as complete as possible to make well-informed choices about reef resources. Moreover, effective management strategies must balance the sustainability of reef ecosystem services with potential economic benefits [21,22]. Marine protection areas (MPAs) have proved to be an effective way to manage human activities while ensuring the conservation of reef resources [23]. More effort ought to be devoted to the improvement of MPAs design and the devising of robust management strategies to meet the public’s desire for conservation [24].

Ecosystem-based management (EBM) has emerged as a widely-used integrated methodology which takes into account the relationship between humans and the environment [25,26]. EBM typically involves the sustainable management of natural resources and biodiversity based on the foundational principle of maintaining the processes of ecosystem functions, services [27], and the concurrent management of both social and ecological systems [28]. Implementing the conceptual framework of EBM requires a sound understanding of how and why various stakeholders may evaluate specific impact conditions regarding the coral reef differently, as well as how these disturbances are connected to the management and conservation goals [3,29].

Taiwan is located at the top northern margin of what has been called a “coral triangle” with its core area lying in the Philippine–Japan arc [30]. The coral habitats of Taiwan are considered to be among the ten most important marine “hot spots” [31] and are inhabited by approximately one-third of the reef species found around the world [32]. However, the coral reefs of Taiwan are also among the top five threatened areas in Southeast Asia [33]. Kenting National Park (KNP), located at the southern tip of Taiwan (Figure 1), is home to an estimated 330 species of scleractinian corals [34], 1300 species of fish, and 134 algae species [35]. At the same time, KNP once boasted the highest biodiversity among all the coral reefs in Taiwan’s marine environment, making it a popular reef recreational area [36]. However, KNP is also faced with disturbances caused by recreational activities on the reef ecosystems, especially those resulting from snorkeling and scuba diving [36]. In other words, the reef ecosystem of KNP is suffering from unsustainable tourism practices, much like many other popular recreational areas around the world [8,11,12].

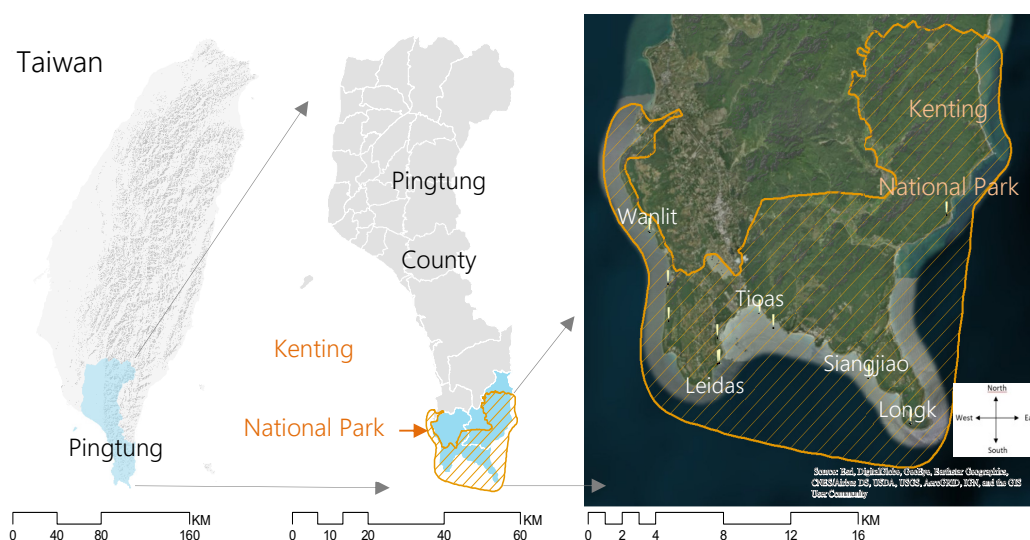


Figure 1. Research scope of reef recreational area in Kenting National Park, Taiwan.

In recent decades, hot topics related to impact reduction management for reef ecosystems have included tourist control and carrying capacity in reef recreational areas [37,38], snorkeling area control and management programs [11,39,40], marine police institutions and surveillance capacity [41–44], mitigating damaging behaviors of divers and snorkelers [11,12,45], environmental education and

environmental briefings [8,46,47], and marine conservation trust funds with marginal willingness to pay (MWTP) for sustainable tourism in MPAs [3,20,29]. There is minimal work aimed at establishing a framework that includes integrated attributes related to impact reduction programs in the field of reef recreational areas, especially focusing on the divers and snorkelers.

The purpose of this study is threefold: (1) To establish a tourist preference function for reef impact reduction programs with choice experiment method (CE). CE is a useful method for policymakers charged with designing various types of regimes based on the evaluation of potential attributes and the value of non-market goods [48–54]. The program includes the attributes and levels of institutional management (providing educational training and setting up marine police) and recreational control (controlling number of divers, setting up a control mechanism in the snorkeling experience area, and taking a boat to the diving location). (2) To evaluate the tourist's preference heterogeneity across demographic segments for various potential management programs for reef recreation. (3) To estimate the welfare values of potential scenarios for reef impact reduction programs.

In Section 2, we provide a summary overview of sustainable reef recreational management and discuss the application of CE to the evaluation of sustainable tourism. Next, this study establishes the hypothetical scenarios with attribute and level design for measuring the tourists' preferences on potential reef impact reduction programs. In Section 3, we present the results from our tourist preference estimation, and discuss the social welfare effects for scuba divers and snorkelers, the preference heterogeneity across tourist demographics, and the evaluation of the effects of multiple scenarios under a reef impact reduction program. Section 4 summarizes our main research contribution. Finally, the last section outlines management strategies for policy-making based on the conceptual framework of the reef impact reduction program presented in this study.

2. Materials and Methods

2.1. Integrating the Theoretical Thinking on Impact Reduction Programs for Reef Recreational Management

The purpose of an impact reduction program for reef management includes institutional management and recreational control [12,16,38,47,55,56]. The carrying capacity is one of the most important aspect of institutional management in coastal or marine areas, and in cases of reefs this often refers to the number of scuba divers and snorkelers who can be supported consistently without any degradation [19], as well as a reference point for ensuring that these and other forms of experience-based tourism will have a minimum impact on the natural and environmental resources in protected areas [38]. Thus, marine resource managers strive to limit the impacts of human activities to acceptable levels and balance the implications of social and ecological factors in protected areas [8,37,38]. From an institutional management standpoint, snorkeling area control focuses on setting entry limitations on divers (or snorkelers) to support reef ecosystem conservation in a protected area [40], or devising and implementing for small scale no-use zone programs [39]. This institutional management approach can reduce the damage and stress to a coral reef caused by the activities of snorkelers and scuba divers [11]. Marine police institutions were established to combat illegal, unreported, and unregulated fishing [42], which can reflect both unsustainable tourism and poor resource management. Vessel monitoring schemes [44] and the establishment of formal surveillance capabilities [41–43] can reduce these negative impacts. Thus, the capacity to police marine areas is a key element for reef recreational activity impact reduction programs and institutional management strategies.

Recreational control is related more closely to the stakeholders' awareness and behavior as these pertain to the management goal of ensuring minimal impact on the protected area agencies [14,45]. It is highly connected to the aspects commonly referred to in the literature as way to the snorkeling site [11,40] and environmental education. Mitigating the damaging behaviors of divers and snorkelers has been found to be highly related to the co-operation of divers, dive operators, and dive masters [11,45]. The ability of operators to set up pre-trip management can change divers' behaviors [11] by avoiding the behaviors that cause breakage [40] through physical contact with the reefs and establishing

management strategies to prevent walking on reefs [12]. Therefore, the aspect of the way to the snorkeling site should be considered in a recreational control mechanism. The tourism impact on reefs can also be reduced by providing pre-dive environmental briefings to training divers (or snorkelers) [8,40]. Environmental education is an effective strategy for reducing human activity impact and protecting marine resources that work through enhancing the public's awareness and skills and banning certain unwanted behaviors [46]. It has been shown that giving environmental briefings to divers can reduce the impact of tourism on reefs [8], and moreover that such briefings can build up the stakeholder's capacity, provide learning opportunities, and enhance knowledge about reef conservation programs [47].

Financial support in the form of a marine conservation trust fund is a tool that can be used to further the goals of sustainable marine tourism, protect ecosystem services, and provide for human well-being [3,29]. Effective reef management can be costly, especially when it comes to the operations and enforcement sectors [20]. Even so, it is possible to provide net economic value while balancing the goals of biodiversity and ecological quality under effective management strategies [21]. Economic value can increase when reef conservation goals are met via suitable management programs [22]. In developing countries, financially feasible tools should be utilized to promote sustainability of marine development and the protection of the coastal and marine resources [3,29]. It has been found that the amount of reef coverage can be increased by a reef management strategy supported by a trust fund from divers' fees [22]. Moreover, in investigating marine environment management and maintenance, Schuhmann et al. [29] indicated that establishing a sustainable financial framework that enhances the capacity for the economic viability of related experiential-based products can serve to advance the long-term goals of marine resource conservation. Thus, it is interesting to understand the different preferences and values of stakeholders, in terms of how they evaluate potential improvement conditions associated with management and conservation goals in the context of reef conservation fund [3].

Based on the above discussion, we propose an impact reduction programs for reef recreational management and identify the following six attributes: controlling the number of divers, controlling the snorkeling experience area, the way to the snorkeling site, education training, marine police, and willingness to pay. Thus, the conceptual framework of this research is revealed in Figure 2, and the detailed description based on results from this study is relegated to the Section 5.

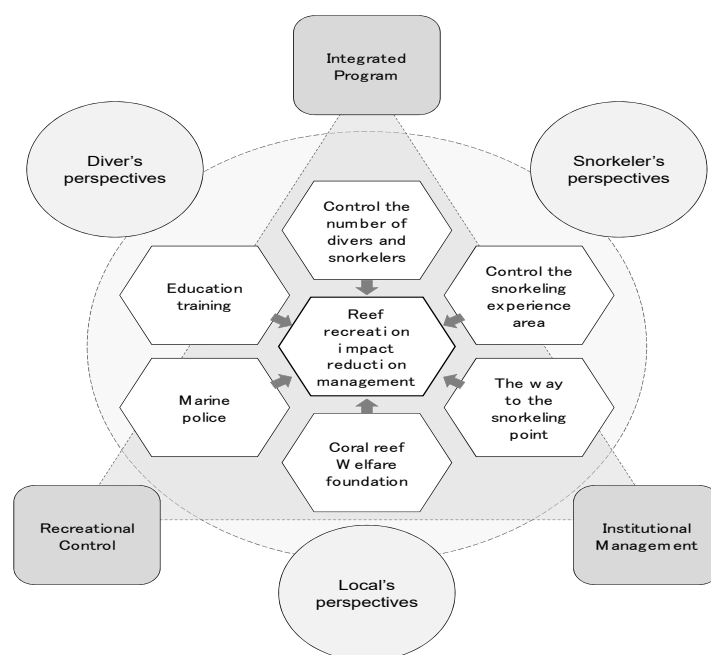


Figure 2. The conceptual framework for an impact reduction program in a reef recreational area.

2.2. The Application of the Choice Experiment to the Evaluation of Sustainable Tourism

To achieve the goal of effective management of any protected reef area, decision-makers and managers will need to understand the tradeoffs between respondents' preferences for the conservation of the ecosystem and recreational uses [54,57,58]. In a CE model, respondents have been asked to rate the importance of a variety of attributes by completing surveys, with the resulting data providing marine ecosystem managers with useful information about respondent's preferences [57,59,60]. However, this approach does not necessarily provide managers with information about the relative importance of the attributes being evaluated and the potential tradeoffs inherent in management decision-making [48]. To make up for this shortcoming, research in the non-market field can focus on capturing individuals' multiple preferences and MWTP [61,62], and the CE can be used to provide respondents with a menu of alternative options for the evaluation of non-market goods [63].

This study adopts the CE model and uses the technique of a survey that captures the respondents' preferences towards the identified focal aspects of a reef impact reduction program. The CE model was selected, in part, due to its suitability for evaluating individuals' preferences and MWTP based on the level change of future quality improvements or impact reduction programs [57,59,60,64,65], for testing the heterogeneity of preferences for attributes among individuals with diverse demographics [59,64,66], and for establishing potential policy scenarios with reference to the welfare effects [3,57,59].

2.3. The Attribute Design of Tourists' Preferences under an Impact Reduction Program in the Reef Recreation Site

We first established the attributes and levels regarding the literature review of marine protected areas, marine tourism, recreational reef scuba diving activities, and impact reduction programs. Second, this study conducted on-site interviews and focus group discussions (FGDs) with members of a reef conservation association, managers of a national park, employees of non-governmental organization, and ecological economists [57,59,62]. All of the above stakeholders were working in Taiwan at the time. According to the opinions garnered from the FGDs and our literature review, this study chose the following six attributes of a potential reef impact reduction program: (1) Set up control of the number of divers [38,55,57]; (2) set up control of the experience area [40,56]; (3) the way to the snorkeling site [11,12,45]; (4) education training [8,11,47]; (5) marine police [41–44]; (6) willingness to pay [3,21,29]. The tourist's preferences for attributes and levels of a potential reef impact reduction program are shown in Table 1.

2.3.1. Set up Control of the Number of Divers (or Snorkelers)

The issue of carrying capacity is commonly encountered in management programs for reef recreational areas. It falls under the overarching rubric of institutional management mechanisms for reef impact reduction programs. For our investigation of tourist preferences for various reef impact reduction program, we chose "control the number of divers" as the first attribute. Here, we set the current situation (i.e., having no carrying capacity mechanism for the divers) and added "set up a control mechanism for the number of divers" as an option (Table 1).

2.3.2. Set up Control of the Experience Area

Sound institutional management is critical for ensuring the effectiveness of any preventive mechanisms incorporated into a reef impact reduction program. The current situation at the reef recreational site under consideration is "no control mechanism at the snorkeling experience area in Kenting". Thus, we added "Setting up a control mechanism in the snorkeling experience area" as an option for the "controlling the snorkeling experience area" attribute.

2.3.3. The Way to the Snorkeling Site

“The way to the snorkeling site” is another important aspect of a potential reef impact reduction program, an attribute especially relevant in Kenting. Most of divers wear rubber shoes, and step on the reefs walk towards ocean until the depth is enough to put fins on, and then swim/dive to the destination. The lower tide, the greater the number of reefs to be harmed. To reducing the deleterious impact of reef recreational activities, we added “take a boat to the snorkeling (or scuba diving) site” as an alternative option.

2.3.4. Education Training

Environmental education for scuba divers and snorkelers before participating in reef recreational activities is another aspect of impact reduction programs. This study set the current status as “no tourist’s education before snorkeling (or scuba diving) activity” and added the option of “provide educational training before snorkeling (or scuba diving) activity”.

2.3.5. Marine Police

Another key aspect of institutional management of reef impact reduction programs involves marine police (or patrol surveillance capacity). Although monitoring, control, and surveillance capacity (MCS) is a key element of reef ecosystem protection, appropriate mechanisms are not always in place. Thus, for the attribute of marine police, the status quo was set as “no marine police”, and we added, “setting up a marine police institution” as the alternative.

2.3.6. Willingness to Pay

To estimate the welfare values with financial attributes based on Equation (2), this study use WTP for a coral reef welfare foundation. This allows us to uncover the tourists’ willingness to pay for a reef recreation activity impact reduction program. With reference to the results of our pretest questionnaire which contained questions in open-ended form, we added five levels based on the current situation, including “NT\$100”, “NT\$200”, “NT\$300”, “NT\$400”, and “NT\$500”, with WTP measured per tourist per trip.

Table 1. The attributes and levels for the impact reduction program for the reef recreational area.

Attributes	Levels	Variable Name
Set up control of the number of divers (or snorkelers)	a. Current situation: no carrying capacity mechanism for divers (or snorkelers) b. Set up a number control mechanism for divers (or snorkelers)	VIS
Set up control of the experience area	a. Current situation: no control mechanism in the snorkeling experience area b. Set up a control mechanism in the snorkeling experience area	EXP
The way to the snorkeling site	a. Current situation: walk to the snorkeling point b. Take a boat to the snorkeling (or scuba diving) point	WAY
Educational training	a. Current situation: no tourist education before snorkeling (or scuba diving) activity b. Provide educational training before snorkeling (or scuba diving) activity	EDU
Marine police	a. Current situation: no marine police b. Set up a marine police institution	POLI
Coral reef welfare foundation	a. No pay (status quo) b. NT\$100/trip/person c. NT\$200/trip/person d. NT\$300/trip/person e. NT\$400/trip/person f. NT\$500/trip/person	FUND

2.4. The Questionnaire Design for the Reef Impact Reduction Program

Based on the design procedures of the CE methodology [57,61], the first part of the questionnaire includes the tourists’ behavior during the trip, and the third part focuses on the respondents’ demographics [67]. However, the second part of the questionnaire in the CE model probes respondents’ preferences regarding potential reef impact reduction programs in the form selected focal attributes and levels (Table 1).

The number of attributes and levels of potential reef impact reduction programs give rise to 192 potential profiles ($2 \times 2 \times 2 \times 2 \times 2 \times 6 = 192$). We used an orthogonal main effect design to design our CE questions, which is frequently used in empirical studies [48,57,59,62]. We employed the procedure to reduce the 192 possible profiles to 16 alternatives for the reef impact reduction program (including the current situation). This study created three combinations of each alternative [48] and deleted the unreasonable combinations, leaving us with a total number of 13 combinations. We then designed two versions of the questionnaire [57,59]. We provide an example of the CE question based on the reef impact reduction program (Figure 3). Each alternative is related to the same attributes of impact reduction program, but will have different descriptive level conditions for reef impact reduction program (i.e., attributes levels).

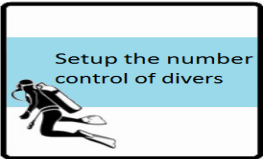
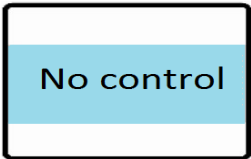
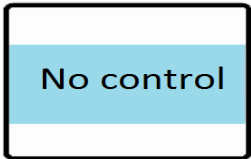
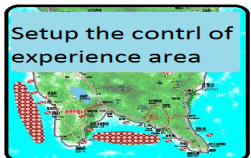
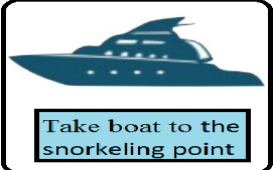
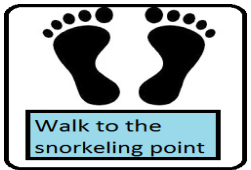
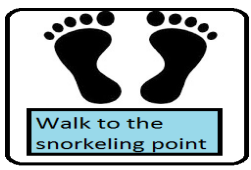
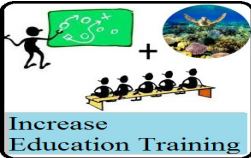
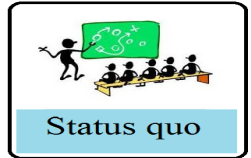
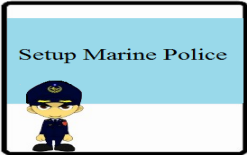
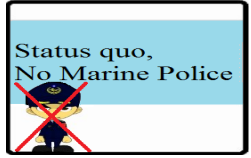
Choice set 1	Alternative1	Alternative2	Status Quo
Set up control of the number of divers (or snorkelers) (VIS)			
Set up control of the experience area (EXP)			
The way to the snorkeling site (WAY)			
Educational Training (EDU)			
Marine Police (POLI)			
Coral reef welfare foundation (FUND)	300	400	0
Choice	NT\$/trip/person ☐	NT\$/trip/person ☐	NT\$/trip/person. ☐

Figure 3. An example of a choice set for the reef impact reduction program in the reef recreational area.

2.5. Establishing the Preference Function for the Impact Reduction Program in the Reef Recreational Area

The CE methodology captures individuals' preferences regarding the characteristics of goods and services [57,68]. The random parameter logit (RPL) model, which is an extension of the traditional conditional logit model, can be used to test the individual's preference heterogeneity [61,69] suitable to evaluate the heterogeneity of respondents' preferences for a reef impact reduction program. Moreover, the LCM can also reveal the sample's preference heterogeneity by estimating the preferences for

attributes and levels across demographics. To do this, the homogenous preference is classified into a specific segment, where the segment membership is characterized by the attitudinal, behavioral, and socio-economic characteristics of the population [57,70].

We first estimate preferences heterogeneity for the reef impact reduction program based on the RPL model. Then we used the LCM to characterize the observed individual-specific characteristics (such as income, tourist type, and whether or not tourists have joined environmental groups). To assess the goodness of fit (GOF) [57,71] for the preference function of the reef impact reduction program, we assessed the statistical significance for log-likelihood ratios (LLR) in our model. The preference function of our study incorporating attributes and levels for the reef impact reduction program (Table 1) can be represented with the following Equation:

$$V_j = \beta_0 \times ASC + \beta_1 \times VIS_j + \beta_2 \times EXP_j + \beta_3 \times WAY_j + \beta_4 \times EDU_j + \beta_5 \times POLI_j + \beta_6 \times WTP_j \quad (1)$$

where V_j is the utility function for the reef impact reduction program relative to the alternative j and the other attributes and levels [57]. The alternative-specific constant (ASC) is the dummy variable for the option of the current situation for the reef impact reduction program for each alternative [59]. β_0 is estimated coefficient for alternative i , and the respondent chose the option of the status quo means $ASC = 1$, otherwise $ASC = 0$. The other independent variables in this study are described as follows:

VIS_j : the attribute of controlling the number of divers, such that $VIS = 1$ means the respondents had a higher preference for setting up a control mechanism for the number of divers, otherwise $VIS = 0$;

EXP_j : the attribute of controlling the snorkeling experience area, with $EXP = 1$ indicating the respondents had a higher preference for setting up a control mechanism in the snorkeling experience area, otherwise $EXP = 0$;

WAY_j : the attribute of the way to the snorkeling site, with $WAY = 1$ meaning the respondents had a higher preference for taking a boat to the snorkeling point, otherwise $WAY = 0$;

EDU_j : the attribute of educational training, and $EDU = 1$ means the respondents had a higher preference for providing educational training to tourists before the snorkeling (or scuba diving) activity, otherwise $EDU = 0$;

$POLI_j$: the attribute of marine police, where $POLI = 1$ means the respondents had a higher preference for setting up a marine police institution, otherwise $POLI = 0$;

WTP_j : the willingness to pay for a coral reef welfare foundation, measured according to levels which were decided based on the results of the on-site survey.

This study calculates the values of MWTP by reference to the estimation results of the tourist's preferences. The MWTP for a reef impact reduction program with level change can be measured by the ratios of the attribute parameters and the financial attribute, as written in Equation (2) [57,59,62].

$$MWTP = -\beta_{\text{attribute}} / \beta_{WTP} \quad (2)$$

where $\beta_{\text{attribute}}$ is the attribute's coefficient for the tourists' preference for the reef impact reduction program, and β_{WTP} is the attribute's coefficient of the WTP [57,59]. To sum up, this study measures the welfare values by reference to the empirical results of Equations (1) and (2).

2.6. Hypothetical Scenarios for a Future Impact Reduction Management Program in a Reef Recreational Area

The CE model has been used in a welfare evaluation of land use programs in semi-watersheds [58], in a study of the welfare effects of impact reduction programs in bird-watching island areas [60], in MWTP evaluation under different land-use scenarios surrounding a forest park [62], in MWTP estimation of integrated programs under CBE in areas close to a forest park [59], for the evaluation of welfare values attaching to multiple sustainable development plans for a national park [57], and in revealing the MWTS values under multiple bird-watching scenarios in a black-faced spoonbill watching site [67]. The aforementioned studies all successfully used the individuals' preferences for chosen attributes and levels.

This study establishes a variety of hypothetical reef impact reduction management programs embodying the selected attributes and levels. Following the estimation results of the RPL model, we can estimate the MWTP based on Equation (2), and evaluate the welfare values related to the reef impact reduction management programs by reference to the alternative options. The potential scenarios for the reef impact reduction program are summarized below.

Scenario I—Institutional Management: This program focuses on “setting up carrying capacity control for snorkeling and scuba diving tourists”, “setting up a control mechanism for the experience area”, and “setting up the marine police”. As for the attributes of “the way to the snorkeling site” and “educational training”, this program maintains the current situation.

Scenario II—Recreational Control: This scenario focuses on “taking a boat to the snorkeling point”, and “increasing educational training before snorkeling and scuba diving”. Compared to other scenarios, this reef impact reduction scenario concentrates primarily on the management of the reef recreational site itself. Thus, this program maintains the attributes of “controlling the number of divers”, “controlling the diving experience area”, and “marine police” at the current levels or status quo.

Scenario III—Integrated Program: This scenario for a reef impact reduction program contains all the potential improvements, and therefore includes “set up carrying capacity control for the snorkeling and scuba diving tourists”, “set up a control mechanism for the experience area”, “take a boat to the snorkeling point”, “set up marine police”, and “increase educational training before snorkeling and scuba diving”.

2.7. Sampling Method and the Demographic Statistics

This study interviewed visitors using an initial questionnaire in early March, 2016. We then modified and used the questionnaire based on the current situation (status quo), responses from focus group discussions, and the initial interview results, and subsequently used the revised formal questionnaire to conduct our investigation from April to October 2016. We still employed used random sampling to conduct on-site face to face interviews and provided guidance to help the respondents understand the questionnaire when necessary. The sampling sites were distributed within the Kenting area and chosen according to where tourists regularly engaged in snorkeling and scuba diving activities. We collected a total sample numbering 1068 respondents. In terms of the sample distribution, 615 respondents were snorkeling tourists, while 453 were scuba diving tourists. In terms of the socio-economic backgrounds of the tourists we interviewed, there were 675 female respondents (accounting for 63.3% of the total sample). There were more unmarried (734 respondents, 67.8%) interviewees than married ones (334 respondents, 32.2%). The twenties was the largest group (477 respondents, 44.6%); the second largest group was the thirties (257 tourists, 24.1%). As for educational background, 739 interviewees had university degrees (69.2%), while 190 interviewees had schooling at the senior high school level (17.8%). Regarding occupation, the 263 interviewees who were engaged in service comprised the largest group (25.6%), while 168 interviewees were engaged in providing expertise (15.7%), with workers in industry and public employees comprising the third (10.2%) and fourth (8.0%) largest groups, respectively. Looking at average personal income, 396 respondents reported earning 20,000 to 40,000 NTD (new Taiwan dollars) per month (37.1%), 256 respondents reported earning less than 20,000 NTD per month (23.9%), and 246 respondents reportedly earned 40,000 to 60,000 NTD per month (23.1%). There were 174 respondents (16.3%) who had previously participated in environmental groups, while 358 respondents (33.5%) had prior diving experience in other countries, and 387 respondents (36.2%) held a diving license.

3. Results and Discussion

3.1. Results of the Tourists' Preferences for an Impact Reduction Program in the Reef Recreational Area

This study evaluates and estimates tourists' preferences for an impact reduction program in a reef activity site with the RPL model and through an interaction effect based on ASC and FUND with

different stakeholder groups (Table 2). For the GOF of the model [54,57,62], the log likelihood ratio (LLR) was calculated by using the formula $LLR = -2(LL1-LL2) = 1465.3$ (Table 2), and indicated that all the models were statistically significant at the 99% confidence interval. The negative correlation and statistically significant sign of coefficients and t-value for ASC indicating that the tourists had a higher preference for changing the status quo regarding a reef impact reduction program.

Table 2. Estimated results of the tourists' preferences for the program of reef impact reduction.

Attributes	Coefficient (t Value)	Coefficient Std (t Value)	Interaction with ASC		
			Attributes	Coefficient (t Value)	Coefficient Std (t Value)
ASC	−2.680 (−6.27) ***	5.960 (12.40) ***	ASC	−0.343 (−0.67)	5.625 (12.14) ***
VIS	0.3264 (6.10) ***	0.7036 (6.74) ***	VIS	0.329 (6.28) ***	0.659 (6.58) ***
EXP	0.1228 (2.65) ***	0.0174 (0.11)	EXP	0.124 (2.72) ***	0.0379 (0.28)
WAY	0.0997 (2.03) **	0.7396 (7.40) ***	WAY	0.0975 (2.00) **	0.741 (7.55) ***
EDU	0.4330 (8.30) ***	0.5614 (4.83) ***	EDU	0.4327 (8.33) ***	0.536 (4.85) ***
FUND	−0.00189 (−6.05) ***	−	FUND	−0.00191 (−6.19) ***	−
			LOCAL	−1.211 (−0.60)	5.505 (2.04) **
			SCU or SNO	−2.92 (−5.97) ***	0.0094 (0.02)
			INCOME	−1.198 (−2.22) **	1.216 (2.37) **
Log-likelihood ratio			1521.7		
Chi Square			$\chi^2_{0.01}(19) = 36.2$		
1465.3			$\chi^2_{0.01}(13) = 34.5$		

*, **, ***—Significant at 1%, 5%, 10% level respectively. The variable ASC represents status quo; LOCAL represents local residents; SCU represents scuba diver; SNO represents snorkeling diver, and INCOME represents subjects whose monthly income more than 40,000 NT dollars.

Based on the empirical results of the RPL model, VIS, EXP, WAY, EDU, and POLI were all statistically significant at the 99% confidence interval (Table 2). There was heterogeneity in tourists' preferences for the reef impact reduction program, as supported by a statistically significant coefficient of standard error for the main attributes at the 99% confidence interval. Furthermore, the coefficient of the interaction term between ASC and SCU was statistically significant ($p = 0.01$), showing that the snorkeling tourists had a higher preference for the alternative reef impact reduction program (Table 2). Moreover, the coefficient of the interaction term between ASC and INCOME was also statistically significant ($p = 0.05$), indicating that the higher income respondents had a higher preference for the reef impact reduction program (Table 2). Based on the above results, setting up carrying capacity control for snorkeling and scuba diving tourists, setting up a control mechanism for the experience area, taking a boat to the snorkeling point, increasing the educational training before snorkeling and scuba diving, and setting up marine police are all positive and significant factors in the tourists' preferences for a potential reef impact reduction program scenario vis-à-vis the attributes and the coral reef welfare foundation.

3.2. Welfare Effects for the Program of Reef Impact Reduction among Scuba Diving and Snorkeling Tourists

For the welfare analysis of selected scenarios of impact reduction program in the reef activity area, we can use the results of Equation (2) in Table 3 to estimate the MWTP for each attribute in a particular scenario (the last row in Table 3). The MWTP values for the considered attribute levels are based on the coefficients of the RPL model (Table 2) and show the average values of the respondents. Furthermore, we divided the respondents into snorkeling and scuba diving tourist groups, and also analyzed the MWTP welfare for each group. All the respondents are willing to pay the highest fee for setting up marine police (NT\$235.6/trip/person), followed by providing educational training before

snorkeling and scuba diving, setting up a carrying capacity control for snorkeling and scuba diving tourists, and setting up a control mechanism for the experience area (Table 3). The MWTP for taking a boat to the snorkeling point was the lowest (NT\$54.6/trip/person). The results indicate that snorkeling tourists were willing to pay the most for setting up marine police (NT\$227.4/trip/person), followed by providing educational training before snorkeling and scuba diving, setting up carrying capacity control for snorkeling and scuba diving tourists, and setting up a control mechanism for experience area. However, their MWTP for taking a boat to the snorkeling point was the lowest (NT\$44.0/trip/person) (Table 3). As for the scuba diving group, the respondents' highest MWTP was for setting up marine police (NT\$246.8/trip/person), followed by providing educational training before snorkeling and scuba diving, setting up carrying capacity control for snorkeling and scuba diving tourists, and taking a boat to the snorkeling point. Finally, setting up a control mechanism for the experience area was associated with the lowest MWTP (NT\$65.0/trip/person) for scuba divers.

Table 3. The marginal willingness to pay (MWTP) results for snorkeling and scuba diving tourists.

Attributes	Snorkeling (N = 615) (NT\$/trip/person)	Scuba Diving (N = 453) (NT\$/trip/person)	All (N = 1068) (NT\$/trip/person)
VIS	160.5	184.9	170.8
EXP	64.9	65.0	65.0
WAY	44.0	68.9	54.6
EDU	220.9	239.6	228.6
POLI	227.4	246.8	235.6
Total	717.7	805.2	754.6

3.3. Testing the Tourists' Preference Heterogeneity for the Reef Impact Reduction Program

The latent class model (LCM) revealed the existence of two latent classes (Table 4). Respondents' education level [57,72], nationality [52,57], and travel behavior [57] are all statistically significant variables. Tourist type, monthly income, and whether or not tourists had joined conservation groups are parameters that differentiate tourists' membership across groups.

Table 4. Estimated coefficients from latent class model (LCM) model.

Attributes	Class 1		Class 2		Class 3	
	Coefficient	T Value	Coefficient	T Value	Coefficient	T Value
ASC	−58.83	0.001	−36.2	<0.0001	−4.11	−2.79 ***
VIS	0.5746	4.44 ***	−12.50	<0.0001	−0.0265	−0.08
EXP	−0.1596	−1.49	−9.37	<0.0001	1.0238	2.49 **
WAY	−0.4095	−2.97 ***	−3.45	<0.0001	1.7634	3.45 ***
EDU	0.8410	4.43 ***	−3.96	<0.0001	−0.4790	−1.33
POLI	0.8029	4.64 ***	−18.74	<0.0001	−0.2202	−0.65
FUND	0.0026	2.37 **	−0.0559	<0.0001	−0.0141	−3.78 ***
Probability	0.501		0.234		0.265	
Class membership coefficients:	Class 1		Class 2			
	Coefficient	T Value	Coefficient	T Value		
Constant	0.42916	2.09 **	0.29004	1.61		
Scuba diving tourists	0.44198	1.88 *	−0.41228	−1.82 *		
Monthly income more than 40 thousand NT dollars	0.03576	0.22	−0.29437	−1.97 **		
Joined conservation groups	−0.10565	−0.50	−0.39586	−1.87 *		
Log-likelihood ratio	467.05					
Chi Square	$\chi^2_{0.01}(29) = 48.3$					

***, **, *: Significance at 1%, 5%, 10%.

The first group contained the largest proportion of total respondents (50.1%), and had a preference for attributes of VIS, EDU, and POLI for snorkeling and scuba diving tourists. While this group would be willing to pay more to support a coral reef welfare foundation, they were unfavorable towards taking a boat to the snorkeling site and for choosing the alternative program of reef impact reduction. Moreover, the class membership coefficients (CME) reveal that most respondents in this group were

the scuba diving tourists. The second group made up of snorkelers with lower-income and no prior involvement in conservation group were among the lowest proportion of total respondents (23.4%). These tourists would not choose the alternative program of reef impact reduction, and had not have any preference for all the attributes. Finally, the third group contained more than one fourth of the total respondents (26.5%). This group chose the alternative program of reef impact reduction, and had a preference for setting up EXP mechanism for the experience area and taking a boat to the snorkeling site. Moreover, this tourist group was made up of large proportion of scuba divers who reported higher income and had previously joined conservation groups based on the CME.

3.4. Welfare Effects under Potential Management Scenarios under Reef Impact Reduction Program

Our research considered the potential scenarios for a reef impact reduction program with the levels of attributes in the RPL model (Table 2) to capture the economic perspective of protecting reef areas [57–61]. By looking at the tourists' preferences regarding the program of reef impact reduction in the RPL model (Table 5), this study was able to estimate the welfare effects of multiple scenarios for the reef impact reduction program as presented in Table 5. Scenario III was the most preferred scenario for the respondents in our study (95% confidence interval from 738.0 to 771.8 NTD/trip/tourist), followed by Scenario I (95% confidence interval from 459.2 to 483.6 NTD/trip/tourist). Comparatively, Scenario II (95% confidence interval from 269.5 to 297.3 NTD/trip/tourist) was the least preferred scenario. Obviously, the best combination for the program of reef impact reduction from the respondents' perspective involved setting up carrying capacity control for snorkeling and scuba diving tourists, setting up a control mechanism for the experience area, taking a boat to the snorkeling point, setting up marine police, and increasing educational training before snorkeling and scuba diving. Our findings can assist in the planning of future management strategies for impact reduction programs in reef recreational areas.

Table 5. The MWTP results for management scenarios under reef impact reduction program.

Attributes & Levels	Hypothetical Future Scenarios		
	Institutional Management (I)	Recreational Control (II)	Integrated Program (III)
Control the number of divers	Set up carrying capacity control for snorkeling and scuba diving tourists	-	Set up carrying capacity control for snorkeling and scuba diving tourists
Control the diving experience area	Set up a control mechanism for the experience area	-	Set up a control mechanism for the experience area
The way to the snorkeling site		Take a boat to the snorkeling point	Take a boat to the snorkeling point
Marine Police	Set up marine police	-	Set up marine police
Educational Training	-	Increase educational training before snorkeling and scuba diving	Increase educational training before snorkeling and scuba diving
MWTP (NTD/trip/person)	471.4	283.4	754.9
95% Conference Interval (NTD/trip/person)	459.2–483.6	269.5–297.3	738.0–771.8

4. Conclusions

Our results indicate that tourists have a higher preference for the alternative reef impact reduction program in the reef activity site, compared to maintaining the status quo. Our results also reveal that tourists prefer to take a boat to the snorkeling point. Similar findings have been reported in case studies [11,12,45,73]. This research shows that setting up a control mechanism in the snorkeling experience area raises the level of awareness in tourists [40,56]. We recommend that a comprehensive program for reef impact reduction should include consideration of the way to the snorkeling site.

Furthermore, we found that the tourists have the highest preference for setting up marine police in the reef activity area, which is a measure that is suggested by other case studies of fishing monitoring, control, and surveillance capacity (MCS) and patrol surveillance capacity [41–43]. The scuba diving and snorkeling tourists also clearly have a higher preference for increasing and obtaining more educational training in the reef activity site, and is in line with findings in related studies [8,11,47]. Thus, marine resource managers should think about developing training programs to enhance the depth, interactivity,

and educational value of activities in reef activity sites when implementing reef impact reduction programs. Moreover, this finding indicates that the issue of carrying capacity is a significant attribute for reef impact reduction management, which is supported by other work [38,55].

We also found that all tourists have a higher preference for the alternative program of reef impact reduction and preference heterogeneity between three identified latent classes. Our results from Table 4 are supported by previous works [57,59,64,65,74]. Thus, our results inform appropriate market segmentation for any program of reef impact reduction in the Kenting area and can aid in the design of environmental education and reef conservation programs for sustainable marine tourism, both there and elsewhere.

Finally, this study established three potential scenarios from the combined attributes of a reef impact reduction program to assist in decision-making-with-welfare evaluation based on the potential establishment of a welfare foundation for coral reefs. The optimal program of reef impact reduction, from a welfare standpoint, was found to be the integrated program, followed by the institutional management approach, and recreational control approach, respectively. The best scenario for a reef impact reduction program for the sustainable marine management [54] in the reef recreational area can be achieved by the following: setting up carrying capacity control for snorkeling and scuba diving tourists, setting up a control mechanism for the experience area, having tourists take a boat to the snorkeling point, setting up marine police, and increase educational training before snorkeling and scuba diving.

Kenting's reef ecosystem services include a variety of functions which include fisheries, coastal protection, culture and education, and tourism. Like other reef ecosystems around the world, Kenting's reef activity area is threatened by human impacts and climate change. We propose that managers of reef activity sites should integrate concepts such as carrying capacity, experience behavior, and environmental education into their services. Moreover, it is incumbent on managers to make appropriate institutional adjustments that are informed by and in line with tourists' preferences for reef impact reduction management.

5. Proposed Management Implications and Conceptual Framework for a Reef Impact Reduction Program

Based on the results of our study, we propose the following conceptual management framework (Figure 2). First, the main evidence of this study reveals that marine protected area managers should incorporate control over the number of divers, control of the snorkeling experience area, controlling the way to the snorkeling site, educational training, marine police, and a welfare foundation for coral reefs as elements of effective frameworks for the promotion of reef impact reduction programs [4,8,11,38,40,42,47,55–57,73]. Second, incorporating the qualitative and quantitative data into the evaluation of tourists' preference heterogeneity and demographics [57,59,64,65] would help the policy maker and program manager to create target segmentation strategies to create reef impact reduction program. Our work also helps the managers of marine protected areas to systematically implement optimal frameworks for reef impact reduction programs based on future management guidelines. Third, the managers of marine protected area and reef recreation activities might choose to focus on the higher-income earning scuba diving tourists who had previously joined conservation groups. They had the highest MWTP for the attributes of the reef impact reduction program in this study and targeting them may bolster protection efforts and environmental education. Finally, for the positioning and planning of a reef impact reduction program for the sustainable marine management [54], the managers should focus on setting up a carrying capacity control mechanism for snorkeling and scuba diving tourists, setting up a control mechanism for experience area itself, facilitating tourists taking a boat to the snorkeling point, setting up a marine police institution, increasing educational training before snorkeling and scuba diving, and establishing a coral reef welfare foundation in order to advance the goals of sustainability and marine ecotourism simultaneously in the protected area.

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