

Estimating Economic Values for Pigeon Island National Park, Sri Lanka: Towards Designing Economic Instruments to Minimize Anthropogenic Degradation



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Abstract: Pigeon Island National Park (PINP), a vital Sri Lankan Marine Protected Area, faces severe anthropogenic degradation stemming from rapid post-conflict tourism growth, excessive plastic accumulation, and illegal fishing. Institutional financing failures, where tourism revenue bypasses local conservation efforts, necessitate the design of sustainable, market-based instruments. The primary objectives of this study were to examine threats, estimate visitor Marginal Willingness to Pay (MWTP) for conservation improvements, and design novel, non-tax economic instruments.

The Choice Experiment Method (CEM) was employed to quantify attribute-specific visitor preferences, with face-to-face interviews conducted on a sample of 200 visitors (Jan-Aug 2022). Attributes included reductions in plastic/polythene, illegal fishing nets, crowding, and a monetary contribution (Cost). The resulting Conditional Logit Model was highly significant ($p=0.000$), showing a positive MWTP for all conservation attributes. Key results indicated visitors were willing to pay LKR 564.55 to reduce plastic by 50% and LKR 568.35 to reduce illegal nets by 50%.

These values inform the design of a complementary package of non-tax instruments: 1) A Refundable Deposit System (LKR 564.55) for plastic to address diffuse pollution; and 2) An Annual Insurance Surcharge (LKR 568.35) on boat owners to target sectoral risk. Implementation of these instruments provides a dedicated, re-investable funding source, bypassing the socio-political friction of imposing direct taxes, and offers a crucial blueprint for PINP's sustained ecological health.

Keywords: anthropogenic degradation; refundable deposit; insurance surcharge.

JEL Classification: Q56; Z10; R11.

Introduction

Pigeon Island National Park (PINP) is situated about 1 km off the coast of Nilaveli, in the Trincomalee District (Eastern Province) in Sri Lanka. The Park covers approximately 471.4 ha, including both terrestrial and marine environments. The area was designated as a sanctuary in 1963 and later upgraded to a national park in 2003 to provide stronger protection for its ecological resources (Coastal Conservation Department, 2013). The park is renowned for its well-preserved coral reefs, which host over 100 coral species. PINP is home to a rich array of marine species, including over 300 species of reef fish. The islands host various bird species, including the rock pigeon (*Columba livia*) (Coastal Conservation Department, 2013). Boundaries of PINP are denoted in figure 1 and figure 2 illustrates the geographical location of the PINP within the territorial boundaries of Sri Lanka.

Figure 1. Boundaries of Pigeon Island National Park

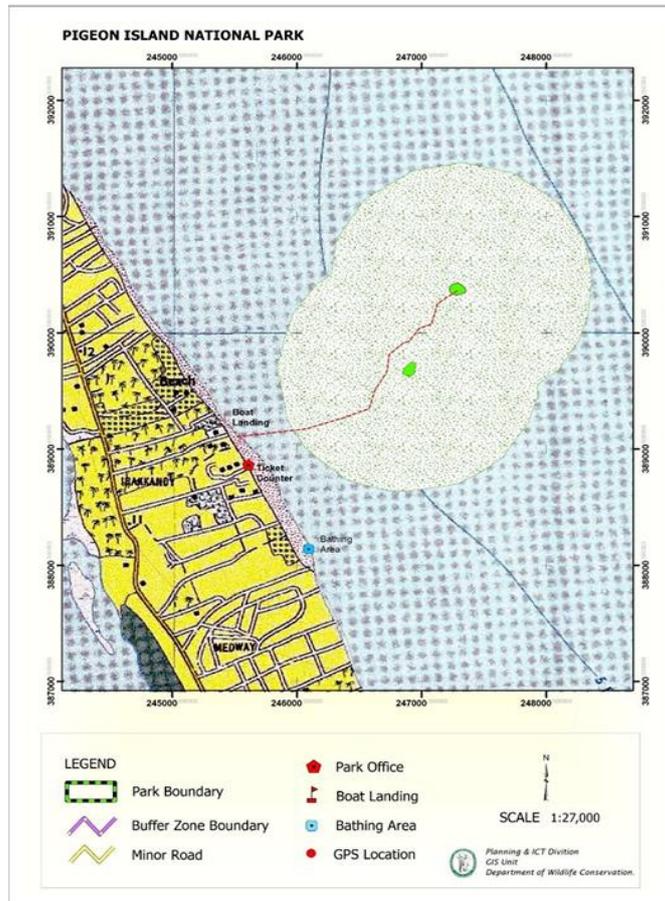
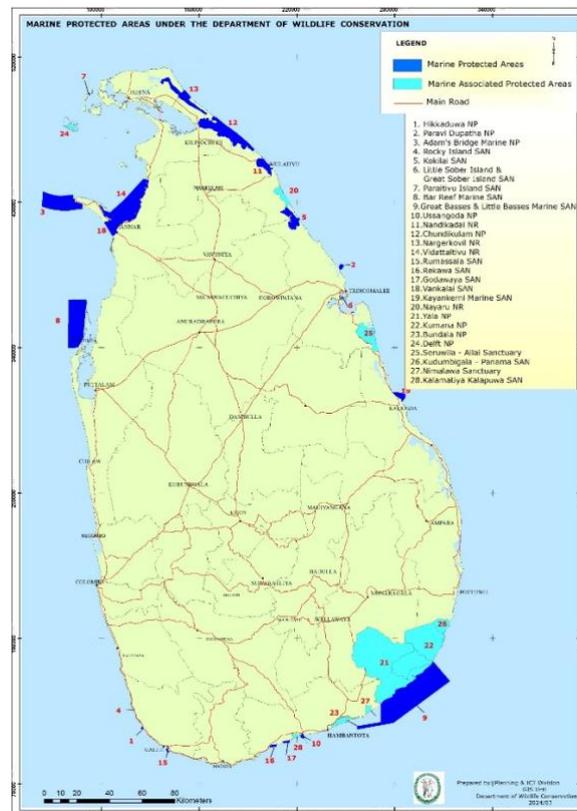


Figure 2. Location of the Pigeon Island National Park in Sri Lanka



Sri Lanka has become a tourist hotspot at the end of the civil conflict in 2009. Inbound tourism is growing rapidly, and a considerable percentage of foreign tourists visit PINP as well. Moreover, there is a considerable number of people who are dependent on edible and non-edible fish species beyond the boundaries of PINP.

Although the tourism sector is earning a significant amount of income, Visitor pressure has negatively affected PINP due to increased demand for natural resources. After the civil conflict, migrant fishermen from the south and northwest are arriving at the east coast during the fishing season, resulting in overexploitation. Furthermore, illegal fishing methods such as dynamiting and bottom trawling have increased. Excessive usage of plastic and polythene is visible as a consequence of visitor pressure and increased fishing activities. Although PINP was not affected by the tsunami it was moderately affected by the 1998 and 2016 coral bleaching events. Therefore, visible signs of degradation are present in PINP due to both natural and anthropogenic activities.

Despite the ecological significance and the escalating visitor pressure on Pigeon Island National Park (PINP), a comprehensive economic valuation of its ecosystem services remains largely unexplored in the post-conflict landscape. This study addresses a critical research gap by being among the first to integrate visitor perceptions with a marginal willingness to pay (WTP) analysis to quantify the non-market values of PINP's marine and terrestrial assets. Its novelty lies in the transition from purely descriptive ecological assessments to the formulation of evidence-based economic instruments - such as revised entry pricing, environmental levies, or fishing permits - tailored to the specific anthropogenic pressures of the Eastern Province. The importance of this research is underscored by its potential to provide a data-driven framework for policymakers to internalize environmental externalities, ensuring that the burgeoning tourism industry and local fisheries contribute to the park's conservation rather than its degradation. By establishing these economic signals, the study offers a replicable model for the sustainable management of marine protected areas in developing island nations facing similar tensions between economic development and biodiversity preservation.

The objective of this study is to examine the threats to this ecosystem, estimate the marginal willingness to pay from the perspective of visitor perceptions and to design economic instruments that can be used to mitigate the problems. Further, it is expected that these instruments will provide a signal for the policy makers to achieve sustainable management of the national park.

1. Research Background

Degradation of Coral Reef Ecosystems and the Need for Economic Intervention

Coral reef ecosystems worldwide are undergoing significant and pervasive degradation due to a confluence of factors, posing a serious threat to marine biodiversity and coastal ecosystems (Xiao, 2022). The primary drivers of this decline include more frequent global warming events, widespread biological disturbances, and intensified human activities (Xiao, 2022). More specific stressors leading to ongoing decline are dynamite fishing, coral bleaching, poor water quality, and pest species infestations (Cabral *et al.* 2014). In response, governments have adopted passive conservation strategies, such as designating marine protected areas (MPAs), to limit harmful human activities and facilitate natural recovery (Abrina *et al.* 2021). Harmful human activities, however, are often elevated in developing countries compared to developed countries. Economists have extensively utilized analytical approaches to quantify the deterioration of coral reefs and understand the resulting socioeconomic consequences (Laurans *et al.* 2013). The impacts include measurable economic losses, such as a decline in fisheries, reduced tourism revenue, and the loss of essential coastal protection services (Lee *et al.* 2019). Economists employ tools to capture the full range of impacts on human well-being and local economies (Web *et al.* 2021).

Environmental Valuation and Economic Instruments

Modern environmental economics is founded on two core concepts: Environmental Valuation and Economic Instruments (Panaiotov, 1994). While valuation assesses the benefits derived from and damages to nature, economic instruments are designed to execute these values by influencing behaviour and policy (Panaiotov, 1994; Tinch *et al.* 2019). Environmental degradation often stems from the failure of traditional markets to account for the actual value of nature in economic decisions, leading to overexploitation and pollution (Kelemen, 2023). Environmental valuation addresses this market failure by assigning monetary value to natural assets (Estoque *et al.* 2018). Marine and coastal ecosystems, in particular, are often undervalued in traditional economic calculations, leading to their degradation because their full economic benefits and the costs of their degradation are not adequately considered in decision-making. Quantification of ecosystem services - including market-based values (*e.g.*, fisheries income), non-commercial values (*e.g.*, shoreline stabilization), and non-use values (*e.g.*, cultural significance) could make their value visible and understandable to decision-makers. (Emerton, 2014).

This economic valuation serves as an essential informational foundation for the design and implementation of economic instruments to strengthen the sustainable management of marine and coastal resources (Himes-Cornell *et al.* 2018, Keohane *et al.* 2019). These instruments aim to create positive financial and economic incentives for conservation, thereby addressing the root causes of ecosystem degradation and overcoming market and policy failures that currently encourage unsustainable practices (Keohane *et al.* 2019). Economic instruments function by encouraging sustainable resource use based on principles such as polluter pays, user pays, ultimately sharing environmental costs and benefits more fairly, efficiently, and effectively (Wang *et al.* 2022). Emerton (2014) presents a generic list of applicable economic instruments for the sustainable management of marine and coastal natural resources, which are categorized into four functional groups: charge and fee systems, fiscal instruments, market creation and development and financial mechanisms. These instruments are often applied together as complementary packages (Emerton, 2014).

Valuation Methods for Non-Market Goods

Coral reefs are considered non-market goods, necessitating specific assessment methods for benefit evaluation (Lee *et al.* 2019). The Contingent Valuation Method (CVM) and the Choice Experiment Method (CEM), both stated preference techniques, are commonly employed to estimate the value of such goods (Lee *et al.* 2019). CVM is a non-market valuation approach that assesses individuals' preferences for ecosystems in a healthy ecological condition (Lee *et al.* 2019). It estimates individuals' Willingness to Pay (WTP) for conservation or their Willingness to Accept (WTA) the loss of ecosystem services by simulating a non-existent market through survey-based elicitation (Lee *et al.* 2019). Windayati *et al.* (2022) used CVM to assess coral reef ecosystem services in Indonesia. Choi *et al.* (2022) applied CVM to value seagrass species. Booth *et al.* (2022) used CVM to assess international tourists' WTP for community-based shark conservation.

While both are Stated Preference techniques, Hynes *et al.* (2021) highlight several advantages of CEM over CVM:

- **Attribute Valuation:** CEM allows for the estimation of the value of individual attributes of the good (e.g., water quality, marine life), whereas CVM provides only a single lump sum value for a specific scenario (Hynes *et al.* 2021).
- **Trade-Off Simulation:** CEM simulates real-world trade-offs by presenting choices between multiple alternatives, while CVM inquires about WTP for a hypothetical single scenario (Hynes *et al.* 2021).
- **Statistical Efficiency:** CEM yields multiple data points per respondent across scenarios, leading to more detailed data and greater statistical efficiency than the single data point typically generated by CVM (Hynes *et al.* 2021).

Owing to its detail insights and ability to represent trade offs CEM is better suited for comprehensive resource valuation.

2. Gaps in Conservation and the Application of Economic Instruments

Despite extensive research on human-induced damage to coral ecosystems, much of it lacks the development of economic instruments to mitigate these adverse effects (Emerton, 2014). Environmental management in regions like the Bay of Bengal has historically relied on laws, regulations (e.g., protected areas, quotas, bans), and post-damage mitigation (e.g., treating polluted water, cleaning oil spills) (Emerton, 2014). However, neither regulations nor mitigation have proven fully effective. Regulations are costly, difficult to enforce, and can limit economic activities, while mitigation requires high spending and offers only temporary, partial solutions (Oosterhuis *et al.* 2014). Emerton (2014) notes that conservation funding is highly limited in most developing countries, making the high costs of enforcing regulations or repairing damage unaffordable. Crucially, markets and policies fail to reflect the actual costs of resource degradation, resulting in little reward for protecting nature and few penalties for harming it (Emerton, 2014).

Numerous studies have used Stated Preference methods, particularly CE, to assess the value of marine conservation and propose corresponding economic instruments. Wattage *et al.* (2011) used a CE study to propose banning trawling and paying a ring-fenced personal tax of 1\$ p.a. for deep sea coral conservation. Can and Alp (2012) used CE to suggest that residents were WTP for water quality and marine life improvements via increases in their average monthly water bills. Oosterhuis *et al.* (2014) reviewed literature on economic instruments for reducing marine litter, noting the beneficial impact of taxes on plastic bag use and the effectiveness of deposit-refund schemes. Taxes and Fees are commonly used as the payment vehicle in CE studies. Halkos *et al.* (2016) used an increase in the water bill. Davis *et al.* (2019) and Grilli *et al.* (2022) used higher local council and state taxes/annual council tax. Börger *et al.* (2014) and Wallmo and Kosaka (2017) used an additional tax or household federal income tax.

3. Use of Estimated Values towards Designing Economic Instruments

A study on willingness to pay for improving marine biodiversity in Croatia was conducted by Smith *et al.* (2016). In order to conserve habitats and species, they conducted a stated-preference survey of two tourist groups: private boats and ferries. According to WTP estimates, revenues might range from approximately €330,000 to €451,000 per year, depending on various situations. The notion of charging visitor entry fees based on visitor type in accordance with WTP segmentation has been addressed by the authors. This study offers a reliable method for converting WTP into prospective income and fee creation. The possibility for tourist entry fees to provide income for MPA administration has been evaluated by Gelcich *et al.* (2013). But according to research, visitor fees by themselves are not a comprehensive nor an immediate way to fund Marine Protected Areas (MPAs). The study draws attention to the discrepancy between value estimation and the instruments that can realistically bridge the gap between the required funding and the entrance price. By showing that tourist admission fees alone are not enough to pay the entire operational costs, the study calculated the economic worth of the Marine Protected Area (MPA) based on visitor Willingness to Pay (WTP) and the real funding required. They have also said that in order to realistically fill the gap, additional, larger finance sources need to be taken into account, specifically suggesting "direct state/government support".

A stated preference survey comparing natural and artificial reef choices was conducted by Kirkbride-Smith *et al.* (2016) among tourists (snorkel tours). They also computed MWTP for both the natural and artificial reefs. In the context of a park, these figures can be used as the foundation for a single daily user fee. Mwebaze and MacLeod (2013) estimated the annual social welfare and consumer surplus per trip in a Seychelles marine park using the travel cost approach. They looked at the approximate consumer surplus of €128 for visits to a single site, €65 for visitors to many sites, and the total social welfare value of around €3.7 million each year. These numbers provide upper bounds for what visitors value and they can inform maximum feasible fees for funding targets. In their study on valuing an MPA in Indonesia, Baskara *et al.* (2017) reported that the average WTP to conserve the MPA was Rp 18,000; the projected hypothetical market value was approximately Rp 2.129 billion. This study offers a legitimate illustration of how valuation is specifically applied to create a "contribution charge" from the guests. It applies in a developing country context which is similar to Sri Lanka. Ahmad *et al.* (2024) in their study of estimating public willingness to pay at a proposed marine protected area in Malacca, have investigated that average WTP was Malaysian Ringgit 14.38 and this provides a strong WTP value for entrance fee design at a newly proposed MPA.

At Hikkaduwa National Park in Sri Lanka, Jayaratne *et al.* (2023a) calculated the WTP for boat safety to be Rs. 322.52 and the WTP for beach crowd reduction to be Rs. 998.92. These attributes-based WTP estimates can inform the design of differentiated pricing strategies or targeted improvement surcharges extending beyond the scope of standard entrance fees. Jayaratne *et al.* (2023b) have conducted a choice experiment study in Bar Reef Marine Sanctuary in Sri Lanka and investigated that WTP for reduce plastic pollution by 50% is LKR 1,001.18 and if crowding can be reduced by 15% WTP is LKR 998.92. These figures can help to design instruments to control pollution. In order to attain tourism sustainability, Nitiratsuan *et al.* (2022) conducted CVM research for a coast free of marine debris. They have evaluated WTP for a possible admission fee using a CVM scenario. It is a good example where valuation is directly linked to a theme (pollution control) rather than just visitation and can assist in designing surcharges for improved environmental quality. Noe *et al.* (2025) have attempted to assess the tourists WTP to conservation of natural resources in a national park in Thailand using CVM for four types of natural resources namely crab-eating macaques, coral reefs, forest and clean air. They have derived resource-specific WTP values; which emphasizes the importance of valuing multiple ecosystem services rather than just one. This research is useful for designing multi component charges (e.g.: for reef protection + forest + air) or for weighting the instrument by resource value".

When creating economic instruments, valuation estimates like consumer surplus and willingness to pay (WTP) provide a solid empirical base. These instruments - like entrance fees, user charges, or improvement levies - are typically not set equal to the full estimated value. Instead, their design often reflects a cautious proportion, taking into account factors like visitor behavior, cost recovery, accessibility, and the interests of various beneficiary groups. Across the literature, these valuation-based instruments have been applied in diverse contexts, including developed and developing countries, marine parks versus coastal or mangrove ecosystems, and through various methodological approaches such as consumer surplus, WTP, and choice experiments.

4. Contextualizing Instruments for Developing Countries and Sri Lanka

A wide range of economic instruments are applied in developing country context. Among them user fees are a common recurring revenue source, especially where ecotourism is significant. Well-managed ecotourism can

both finance MPAs and involve local communities, as seen in Mozambique and Seychelles (Casimiro *et al.* 2023, Pascal *et al.* 2021 and Bohorquez *et al.* 2022). Impact investment and blended finance is another strategy which uses innovative models that combine public, philanthropic, and private capital to fund MPA management and expansion, as piloted in the Dominican Republic and other Caribbean sites (Pascal *et al.* 2021 and Bohorquez *et al.* 2022). Debt-for-nature swaps also have been used in countries like Seychelles, Belize, Barbados, and Ecuador, though legal and transparency barriers exist. These arrangements convert national debt into conservation funding, providing stable support for MPAs (Jiang *et al.* 2024). Transferable fishing rights and market-based schemes such as rights-based fisheries management and trading schemes and Vessel Day Scheme in the Pacific, incentivize conservation while maintaining economic activity (Villaseñor-Derbeze *et al.* 2020). Biodiversity offsets and compensation payments such as payments from industries (*e.g.*, fossil fuel, shipping) and ecological compensation mechanisms are emerging as alternative funding sources (Bohorquez *et al.* 2022 and Jiang & Cao, 2024).

5. Materials and Methods

In order to achieve the objectives Choice Experiment Method was applied in this study. The choices of the respondents are based on the Random Utility Theory (RUT) and the Consumer Choice Theory (CCT). According to the latter theory, the consumer attains fulfilment, from the attributes of the goods and not from the goods themselves (Lancaster, 1966). For the modelling of CEs, Random Utility Theory is used as the leading theory (McFadden, 1974). According to Random Utility Theory, consumers will choose one alternative over another once the utility derived from that alternative is higher. The utility of choice is comprised of two components, and they are the error term and the deterministic (systematic) term. The error term depicts the uncertainty of the predictions. The utility of a choice can be mathematically represented as follows.

$$U_{ab} = V_{ab}(X_{ab}, S_a) + \epsilon_{ab} \quad (1)$$

U_{ab} denotes the utility that the a th respondent will obtain from choosing alternative b . V_{ab} is the systematic term, which is a function of X_{ab} , the vector that includes the attributes, and S_a denotes respondent's characteristics. Moreover, random error is denoted by ϵ_{ab} . The error term helps to represent the omitted variables and case-specific factors that control utility. This helps the practitioner to include the properties of the unobservable factors.

A respondent would choose alternative "c" over alternative "b" only when the satisfaction obtained is higher. *i.e.* $U_{ac} > U_{ab}$, where U represent utility. So that the probability of the a th respondent choosing c th alternative over "b", from the choice set C , is given as

$$P_{ac} = \text{Prob}(U_{ac} > U_{ab}) \text{ for all } b \text{ in } C, b \neq c \quad (2)$$

$$P_{ac} = \text{Prob}(V_{ac} + \epsilon_{ac} > V_{ab} + \epsilon_{ab} \text{ for all } b \text{ in } C, b \neq c \quad (3)$$

For the b th alternative, V_b is known as representative component utility, and it includes the observed and measured attributes of the individual. Weights attached to each attribute explain marginal utility. The following equation depicts the weights attached to each attribute.

$$V_b = \beta_0 + \beta_{1b}f(X_{1b}) + \beta_{2b}f(X_{2b}) + \beta_{cb}f(X_{cb}) \quad (4)$$

Where β_0 is the alternative specific constant (ASC) which reveals unobserved sources of utility and it does not relate to any of the measured or observed attributes. β_{1b} is the coefficient (weight) of attribute X_1 and the alternative b . Attributes are depicted as functional forms since, based on the model, they can be included in forms such as quadratic, logarithmic, or in combinations (interactions).

To calculate selection probabilities of a choice model, the condition of Independence from Irrelevant Alternatives (IIA) should be satisfied. According to Can and Alp (2012), "the presence or absence of an additional alternative does not affect the ratio of the probabilities of choosing one alternative over another when all alternatives having a non-zero probability of choice are considered."

The IIA assumption indicates that the error terms are identically and independently distributed (IID). An assumption on the distribution of the error terms is made to obtain a meaningful expression for the probabilities. It is assumed that the error terms, ϵ , are identically and independently distributed and they follow a type I extreme value (double exponential or Gumbel, Weibull distribution), the resulting choice made would be expressed as follows.

$$P_{ab} = \frac{\exp(V_{ab})}{\sum_{c \in C} \exp(V_{ac})} \quad (5)$$

It is known as the conditional logit model or multinomial logit model. With Logit models, which are estimated under random utility theory using Maximum Likelihood Estimation (MLE).

5.1 Calculating Marginal Willingness to Pay

Given that one attribute is measured in monetary terms, willingness to pay (WTP) can be found as a ratio of two parameters (coefficients, β s), holding all else constant. In this respect, both of the attributes should be statistically significant. In this calculation, the attribute measured as a monetary term is used in the denominator of the equation. Marginal Willingness to Pay (MWTP) is the ratio of the coefficient of the attribute of interest and the price coefficient (Can and Alp, 2012).

The initial state of the utility is V_0 , the new state to be V_1 and β_c to be the coefficient of the cost attribute. Then, the WTP is given as:

$$MWTP = \beta_c^{-1} \ln \left[\frac{\varepsilon_a \exp(v_a^1)}{\varepsilon_a \exp(v_a^0)} \right] \dots \quad (6)$$

Letting β_k represent the coefficient of any attribute from the above-mentioned equation, WTP can be stated as

$$WTP = -\frac{\beta_k}{\beta_c}$$

5.2 Main user Categories at the Pigeon Island National Park

Pigeon Island National Park (PINP) has become a tourism attraction after the end of the armed conflict in 2009. Since then, the number of visitors to the area is increasing. Hence, 200 visitors who travelled to this destination during the study period were the focus of this study. Moreover, fishing is the main occupation in this area, and hence, fishing is the primary source of income for the villagers. Fishing boats are also used to transport visitors to the island in the lean season. Compared to other local users, such as divers and collectors, there are a few. Tourism is a booming industry in the area, and there is small-scale to large-scale tourist ventures in the PINP area. Compared to other local users, such as divers and collectors, there are few.

5.2.1 Focus Group Discussions and Key Informative Interviews: PINP

In order to gain a better idea of the livelihood of the people, problems they face, and other important aspects to be considered in a choice experiment, two Focus Group Discussions (FGDs) and four Key Informative Interviews (KIIs) were held in the PINP area. Fishermen, boat owners, ornamental fish collectors and hotel owners were involved in FGDs and experts in the field and officers of the Department of Wildlife Conservation (DWLC) were interviewed in KIIs. In the FGDs, participants discussed issues related to the management of fishery resources, traditional and modern fishing techniques used by local fishers, and the types of fishing gear employed, their efficiency, and their impacts on the environment. Existing fishing regulations, their enforcement, and compliance by fishers were discussed. Tourism and related impacts on biodiversity, suggestions for improving tourism in the area in a sustainable manner, and other topics were discussed.

5.2.2. Data Sources

Primary data was the key source of information for the study. A sample of 200 visitors was interviewed using a random sampling method from January to August 2022. They were interviewed at local hotels, resorts, and beach areas. The other two main user groups, hotel owners and fishermen, were included in the focus group discussions. In addition, secondary data available from official sources such as the Coastal Conservation Department and the Wildlife Conservation Department were also consulted.

5.2.3 Preparation of the Questionnaire

Based on feedback from the FGDs and KIIs, a pilot questionnaire was prepared and tested prior to data collection with 50 visitors. According to the feedback obtained for the pilot questionnaire the final questionnaire was prepared.

5.2.4 Conducting the Survey

In the choice experiment method, which was used in this study, the first step was to identify different attributes and their levels. These attributes were identified in the FGDs and KIIs as mentioned above. Table 1 depicts the attributes and levels used in the study.

Table 1. Attributes and levels used in the study

| Attribute | Level 1 | Level 2 | Level 3 |
|--|--|--|--|
| Level of plastic and polythene accumulated | 50% reduction in plastic and polythene | 25% reduction in plastic and polythene | Current level of plastic and polythene |
| Level of crowding on the beach | 30% fewer people | 15% fewer people | Usual number of people |
| Use of illegal fishing nets | 50% reduction in illegal fishing nets | 25% reduction in illegal fishing nets | Current level of illegal fishing nets |
| Monitory contribution | LKR. 1000 | Rs. 500 | No additional contribution |

Four attributes and three levels yield 64 distinct combinations in the main effects design. Showing 64 different combinations in a survey and also asking respondents to select their choice is not practical. Therefore, an orthogonal main-effect design was employed in SPSS 21 to reduce the 64 combinations to 9. These 9 profiles, along with their component attributes and levels, were included in a questionnaire format. With a third fixed alternative corresponding to the status quo, the number of random alternatives in each choice task was set to two. Further, the questionnaire included sections to gather socio-economic information as well. The choice set shown in the study is presented in Table 2.

Table 2. An example of a choice set shown in the study

| Attribute 1 | Attribute 2 | Attribute 3 | Attribute 4 | Choice |
|------------------------------|--|------------------------|-------------------------|--------|
| 50% reduced use of plastic | 25% reduced use of illegal fishing nets | 30% fewer people | No additional fee | 1 |
| 50% reduced use of plastic | 50% reduced use of illegal fishing nets | Usual number of people | LKR 500 additional fee | 2 |
| 25% reduced use of plastic | Continue to use the current illegal fishing nets | 30% fewer people | LKR 500 additional fee | 3 |
| 25% reduced use of plastic | 50% reduced use of illegal fishing nets | 15% fewer people | No additional fee | 4 |
| 25% reduced use of plastic | 25% reduced use of illegal fishing nets | Usual number of people | LKR 1000 additional fee | 5 |
| Current level of plastic use | 50% reduced use of illegal fishing nets | 30% fewer people | LKR 1000 additional fee | 6 |
| Current level of plastic use | Continue to use the current illegal fishing nets | Usual number of people | No additional fee | 7 |
| 50 % reduced use of plastic | Continue to use the current illegal fishing nets | 15% fewer people | LKR 1000 additional fee | 8 |
| Current level of plastic use | 25% reduced use of illegal fishing nets | 15% fewer people | LKR 500 additional fee | 9 |

6. Results

Results were analysed using STATA 14 software, and the model was tested for significance at α 0.01. According to chi-squared estimates, since the p-value of the model is 0.000, which is lower than 0.05, it indicates that this is a significant model at a 95% probability level. Further, the null hypothesis, which reveals that there is no relationship between choice and the attributes, can be rejected. The pseudo R_2 value is 0.1424, which is considered a good model according to Can and Alp (2012). Maximum likelihood estimates of the parameter values are presented in Table 3.

According to the above table regression equation for the model can be presented as follows.

Choice = -0.001 + 0.824 reduce plastic by 50% + 0.830 reduce illegal nets by 50% +0.580 reduce crowding by 30%.

Table 3. Results of Conditional logistic regression for PINP

| Variable | Conditional logit model coefficient | $Pr > \chi^2$ |
|----------------------------|-------------------------------------|---------------|
| Reduce plastic by 50% | 0.824 (0.141) | 0.000 |
| Reduce Illegal nets by 50% | 0.830 (0.164) | 0.000 |

| | | |
|------------------------|--------------------|-------|
| Reduce crowding by 30% | 0.580 (0.161) | 0.000 |
| Contribution | -0.0015 (0.000) | 0.000 |
| Log likelihood | -413.840 | |
| Pseudo R ₂ | 0.1424 | |

Note: Standard errors in parentheses. $Pr > \chi^2$ reports p-values from Wald tests.

The coefficient of 0.824 with respect to "reduce plastic by 50%" indicates that individuals are 0.824 times more likely to choose the alternative associated with reducing plastic by 50%, holding other variables constant. P-value 0.000 suggests that this coefficient is statistically significant, indicating that reducing plastic by 50% has a significant impact on the choice being made.

The variable "reduce illegal nets by 50%" holds a coefficient of 0.830, which indicates that visitors are more likely to choose the alternative associated with reducing illegal nets by 50%, holding other variables constant. P-value 0.000 indicates that this coefficient is statistically significant, indicating that reducing illegal nets by 50% has a significant impact on the choice being made.

Reducing crowding by 30% has a coefficient of 0.580, which reveals that visitors are more likely to choose an alternative associated with reducing crowding by 50%, holding other variables constant. P value 0.000 indicates that this coefficient is statistically significant, indicating that reducing crowding by 30% has a significant impact on the choice being made.

Coefficient of -0.001 indicates that there is a very marginal decrease in the likelihood of choosing alternative per unit increase in 'contribution'. The p value indicates that this coefficient is statistically significant suggesting that the variable 'contribution' significantly influences the choice being made.

6.1 Marginal Willingness to Pay and Proposed Economic Instruments Mathematical Expressions

Since Marginal Willingness to pay is the negative value of the ratio of the attribute coefficient to the contribution coefficient, it is calculated for reduced plastic by 50% as follows. MWTP for reducing the plastic by 50% = $-(0.8244115/-0.0014603) = \text{LKR } 564.55$.

MWTP for reduced plastic by 50% represents the monetary value individuals are willing to pay for each unit reduction of plastic by 50%. According to the model, individuals are willing to pay LKR 564.55 to reduce plastic waste by 50%. Therefore, visitors may be charged a refundable deposit of LKR 564.55 if they bring polythene or plastic into the park.

MWTP for reduce illegal nets by 50% is $-(0.8299599/-0.0014603) = 568.35$

The selection of this instrument is grounded in the economic principles and contextual challenges detailed in the literature review, which emphasizes that environmental degradation stems from the failure of traditional markets to account for the actual value of nature. Economic instruments are designed to execute these values by influencing behavior and policy through principles like the polluter pays and user pays (Emerton, 2014).

The refundable deposit on plastic usage is an application of a Deposit-Refund System (DRS), which falls under the broader category of Charge and Fee Systems or Financial Mechanisms for environmental management. This instrument directly addresses the problem of marine litter and its impact on coral reef ecosystems. Oosterhuis *et al.* (2014), as cited in the literature review, noted the beneficial impact and effectiveness of deposit-refund schemes for reducing marine litter. The refundable nature of the charge leverages positive financial incentives, as opposed to a simple tax, which is necessary to overcome the "widespread reluctance to pay additional taxes" noted in the developing country context of Sri Lanka. Research studies done in their countries confirms the efficacy of DRS over simple taxes, as it avoids the problem of 'midnight dumping' and enhances return rates for high-quality recycling (Walls, 2013). The instrument is further supported by local valuation work. Jayaratne *et al.* (2023) conducted a Choice Experiment study in the Bar Reef Marine Sanctuary (Sri Lanka) and found a Willingness to Pay (WTP) of LKR 1,001.18 to reduce plastic pollution by 50%. This valuation provides an empirical foundation for designing the deposit level to effectively control pollution.

MWTP for reduced illegal nets by 50% represents the monetary value individuals are willing to pay for each unit reduction of illegal nets by 50%. Visitors are willing to pay LKR 568.35 to reduce illegal nets by 50%, according to the model's results. This value states that visitors are concerned about the illegal fishing that destroys the marine ecosystems, and hence the importance of protecting sustainable fishing. LKR 568.35 can be charged to boat owners, in addition to their annual insurance premium, to discourage the use of illegal fishing gear, since the same boats are also used to carry visitors. The additional charge incorporated into the annual insurance premiums operates as a form of Financial Mechanism or Compensation Payment (Emerton, 2014). This mechanism targets the marine-user sector, whose activities - including tourism and fishing - can be a source

of direct impact (e.g., anchor damage, waste discharge), and whose economic activities rely on the health of the resource (Lee *et al.* 2019). The instrument aligns with the User Pays and Polluter Pays principles, ensuring that those who benefit from or risk damaging the asset contribute to its maintenance.

The policy directly addresses the major institutional challenge in Sri Lanka, where MPA funding is limited, and tourism revenues are not effectively reinvested as they are credited to the Treasury. This new revenue stream, collected through the existing financial infrastructure of insurance, provides a mechanism for an "additional, larger finance source" to fill the funding gap that cannot be covered by tourism entry fees alone (Gelcich *et al.* 2013).

MWTP for reducing crowding by 30% is $= - (0.580/-0.01) = 397.43$

MWTP for reduced crowding by 30% represents the monetary value individuals are willing to pay for each unit of reduced crowding by 30%. Visitors are willing to pay LKR 397.43 to reduce crowding by 30%, according to the model results. The above value ultimately implies that at present, the crowding is too much and it should be reduced further.

7. Policy Implications

The integration of the Deposit-Refund System (DRS) and the insurance surcharge create a complementary package of economic instruments, a strategy widely supported in environmental economics (Emerton, 2014).

The main problem is finding ways to pay for conservation in a developing country where many people live and work near protected areas and refuses new taxes. By labelling the DRS as a refundable deposit and the boat levy as an "additional charge incorporated into... insurance", the policy avoids the political friction associated with imposing a new "tax" on local populations and tourists. This strategic framing allows the policy to generate income while accommodating local socio-economic sensitivities.

The policy mix is effective because it targets pollution at two critical scales:

- Diffuse Pollution: The Deposit Refund Scheme targets the widespread problem of plastic litter, which is a general threat to coastal and marine environments. By incentivizing recycling, it mitigates a major stressor leading to reef decline, poor water quality.

- Sectoral Risk: The insurance surcharge targets the higher, specific risk posed by marine vessel operators. This risk is internalized by linking the financial contribution to their existing annual insurance policy, making it an efficient and compulsory system.

Converting Valuation into Policy Action: The local WTP for reducing plastic pollution (Jayaratne *et al.* 2023) and for improving attributes like boat safety (Jayaratne *et al.* 2023) provides the empirical foundation on the use of estimated values as economic instruments. As with other successful conservation fees (Baskara *et al.* 2017), the proposed charges would not be set equal to the full estimated WTP, but would reflect a cautious proportion designed for cost recovery and accessibility. By using the revenue from these instruments to fund MPA administration and enforcement, the policy aims to bridge the gap between the assessed economic value of the MPA and the actual funding required to maintain its health.

8. Public Policy Implications

The study advocates for a transition from descriptive ecological assessments to evidence-based economic instruments. These instruments aim to internalize environmental externalities, ensuring that both tourism and local fisheries contribute to conservation.

- Innovative Revenue Streams: Proposed instruments like the Deposit-Refund System (DRS) for plastics and insurance surcharges for boat owners create a "complementary package" of economic tools. This avoids the political friction of new taxes while providing a dedicated fund for MPA (Marine Protected Area) administration.

- Targeted Regulation: By linking boat insurance premiums to conservation, policymakers can directly influence the behavior of vessel operators, addressing specific risks like the use of illegal fishing gear and physical reef damage.

- Sustainable Management Models: This approach serves as a replicable model for other developing island nations struggling to balance economic development with biodiversity preservation.

Educational and Awareness Implications

The research highlights a clear gap between visitor perceptions and the current state of the park, which can be bridged through targeted educational initiatives.

- Quantifying Values: The study establishes a Marginal Willingness to Pay (MWTP) for various improvements, such as LKR 564.55 to reduce plastic by 50% and LKR 397.43 to reduce crowding by 30%. These figures can be used in educational campaigns to demonstrate the tangible economic value the public places on a healthy ecosystem.

- Behavioral Change: The DRS serves as a practical educational tool, incentivizing visitors to manage waste and highlighting the direct impact of marine litter on coral reef health.
- Safety and Ecological Literacy: The willingness to pay for boat safety and reduced illegal fishing indicates a public concern for sustainable practices, which can be further fostered through park-run awareness programs.

9. Cultural and Social Implications

The study recognizes the socio-economic sensitivities of the Eastern Province, particularly in a post-conflict landscape.

- Community Integration: By framing charges as "refundable deposits" or "insurance additions" rather than taxes, the policy respects the local population's reluctance to pay additional government levies.
- Preserving Heritage: Protecting species like the rock pigeon (from which the island gets its name) and the well-preserved coral reefs is vital for maintaining the local identity and natural heritage of the Trincomalee District.
- Equitable Usage: Addressing the influx of "migrant fishermen" and the resulting overexploitation requires a cultural shift toward shared responsibility and long-term resource sustainability over immediate extraction.

Conclusion

This research has attempted to investigate the threats to the ecosystem, estimate marginal willingness to pay values according to the visitor's perception and to propose Economic Instruments that would be solutions to the existing problems. All the attributes in the presented Conditional Logit model were significant at $\alpha = 0.05$, *i.e.* reduce plastic by 50%, reduce illegal nets by 50%, reduce crowding by 30% and contribution. MWTP for reducing plastic by 50% is LKR 564.55. It reveals that Individuals are willing to pay LKR 564.55 to reduce plastic waste by 50%. Therefore, it can be proposed as an economic instrument to charge a refundable deposit of LKR 564.55 for carrying polythene and plastic into the park.

The MWTP for reducing illegal nets by 50% is LKR 568.35. Hence, it can be charged by the boat owners in addition to their annual insurance premium to discourage the use of illegal fishing gear as an Economic Instrument since the same boats are used to carry visitors as well. Implementation of such instruments would ease the anthropogenic threats in the sensitive ecosystem of the PINP.

Credit Authorship Contribution Statement

Chamathi Jayaratne: Writing – original draft.

Prasanthi Gunawardena: Supervision.

Premachandra Wattage: Methodology, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Use of Generative AI and AI-Assisted Technologies

The authors declare that they have not used generative AI.

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