An Economic Valuation of Coastal Ecosystems in Phang Nga Bay, Thailand[1]

Udomsak Seenprachawong

School of Development Economics
National Institute of Development Administration
Bangkok 10240 Thailand.

Abstract

This study assessed the value placed on changes to the Bay's ecosystems by Thais so that these values can be taken into consideration when decisions are made on the expansion of environmentally damaging commercial activities. The welfare estimates of improving the Bay's ecosystem showed that diversity of flora and fauna, which provides recreational and tourism benefits, is the most important attribute of the Bay. Local livelihood and ecological functions are equally important attributes while the rare and endangered species attribute is the least important.

JEL Classification: H27; Q26
Keywords: Economic valuation; Willingness to pay; Coastal ecosystem; Phang Nga Bay

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1. Issues and Significance of the Problem

Conserving mangroves and coral reefs has become an increasingly important topic of public debate in developing countries like Thailand. This is of particular concern for mangroves and coral reefs in areas such as Phang Nga Bay, covering the coast of the provinces of Phuket, Phang Nga, and Krabi. The Bay was designated as an area for the Southern Seaboard Development Project (SSDP) in the Sixth National Economic and Social Development Plan (1987-1991). The SSDP is intended to combine the national development goals of industrial development to capitalize on domestic natural resources, attract foreign development, and decentralize economic growth. The basic components of the SSDP are two deep-sea ports, industrial estates, urban centers, and highways. There is a strong motivation for coastal area development as some people have argued that net benefits of the development often exceeded those of mangrove forests preservation in the context of a conventional cost-benefit analysis (CBA). In order to address this conflict between conservation and conversion of

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coastal resources, there is an urgent need to understand trade-off for a balance between coastal resources conservation through sustainable utilization and coastal resources conversion by assessing the values of their multiple functions. Furthermore, local communities in Phang Nga Bay are totally dependent on the mangroves and coral reefs for their livelihood. The rapid rate of destruction is evident throughout the area and sustainable coastal resources management options are urgently needed to be identified for the area.

2. Economic Valuation of Coastal Ecosystems

Coastal ecosystems are quite complex as they represent a conglomeration of goods and services, which perform significant ecological functions that arise out of interdependence between their different components. For instance, coral reefs and mangroves require different conditions for optimal growth. Mangroves thrive in calm nutrient-rich environments, whereas coral reefs need clear, nutrient-poor waters. However, reefs and mangroves may be closely linked as they are often found together. Mangroves protect reefs from terrestrial sediments and provide shelter among their roots for juvenile reef fish, like snappers. Coral reefs protect mangroves from erosion during storms and strong wave action.

It may be difficult to reach their accurate benefit estimates. Nonetheless, for a useful means of decision-making on conflicts between their preservation and development, various economic valuation techniques have been adopted in the evaluation of preservation value. Environmental economists employ a total economic value approach that focuses on monetizing a set of human preferences on natural system. The analysis of economic values of coastal resources can be done based on the following functions:

(a) Ecological function: The existence of biodiversity helps to keep ecosystems stable and functioning. Mangroves and coral reefs perform many important ecological functions for man. They are valuable in providing protection against coastal erosion and coastal storms.

(b) Consumption: Plants and animals in the mangroves and coral reefs provide many goods which satisfy human needs. Mangroves and coral reefs provide natural nurseries for large numbers of commercially important species. Many coastal people have lived, fished, and hunted within mangroves, deriving valuable commodities from them such as timber, fuel, medicine and food.

(c) Aesthetic value: Coastal tourism appears to be on the rise throughout coastal cities around the world. Mangroves and coral reefs' potential for tourism are increasingly being explored in recent years.

(d) Future: The importance of conservation of the mangroves and coral reefs' ecosystems in general, takes on an added dimension as scientists are increasingly turning to the biodiversity of the sea in their search for medical cures and unique compounds.

(e) Existence**:** The diverse plants and animals species in the mangroves and coral reefs ecosystems has a need to exist, regardless of their use to us. Some people wish to see them preserved, although they do not currently make use of them.

Each of these functions has an economic value and these values together can be taken to calculate the total economic value of mangroves and coral reefs ecosystems. The total economic value has been classified into use and non-use values derived from individual preferences. In economic literature, natural resource values that are independent of people's present use of the resources have been variously termed as existence, intrinsic, passive use, preservation or conservation values. For decision-making purposes, however, what is of most interest is the change in value that results from a positive or a negative impact on the resource. In other words, how does the value of the resource change if it is degraded or improved by a specific human intervention?

3. Objective of the Study

The general objective of this study is to estimate the economic value of changes to the quality of the mangroves and coral reefs ecosystems in Phang Nga Bay. The specific objectives are as follows:

(a) to estimate the economic value of changes to the quality level of flora and fauna of coastal ecosystems in Phang Nga Bay

(b) to estimate the economic value of changes to the quality level of local livelihood of rural community living in Phang Nga Bay

(c) to estimate the economic value of changes to the quality level of ecological function of coastal ecosystems in Phang Nga Bay

(d) to estimate the economic value of changes to the quality level of rare and endangered species in Phang Nga Bay.

4. Literature Relating to Coastal Ecosystem Valuation

Economic valuation studies pertaining to coastal ecosystems in Thailand are scanty. To date, only three had been done on coastal ecosystems in southern Thailand. These three studies are reviewed here.

Sathirathai (1998) assessed the economic value of mangroves in Surat Thani emphasizing only the use value, which comprised direct and indirect use values. The author identified four components including direct use value of mangroves in terms of (i) local community usage and indirect use value in terms of (ii) off-shore fishery linkages, (iii) coastal line protection, and (iv) carbon sequestration. However, the study had emphasized on the first two components. The direct use value of the mangroves based on local use were assessed from the net income generated by the locals from the mangroves in terms of timber, fuel wood, and other wood and animal products such as birds and crabs collected directly from the mangrove swamps. Indirect use value was determined by the contribution of resources in terms of their environmental and ecological services to support current production and consumption. The study attempted to value the mangroves in terms of their support to offshore fisheries by adopting the Ellis-Fisher (1987) and Freeman (1991) models in which the value in focus was determined by a change in consumer surplus. The author found that the economic value of mangroves was estimated to be in the range of USD 513.05 to USD 658.55 per rai (1 rai = 0.16 ha).

Chuenpagdee (1998) argued that research of the past had not provided reliable methods for measuring the economic value of most non-marketable environmental goods. The author used a damage schedule as an alternative approach to assess coastal resources in southern Thailand. A damage schedule is constructed based on scales of relative importance obtained from people's judgement about values of various resource losses and activities causing losses. An attempt was made to obtain monetary values of the resource losses using the method of paired comparisons. Respondents were asked to choose between loss of resource and loss of money. It was found that the monetary estimate for partial damage to mudflats in Ban Don Bay was 1,350 Baht (USD 33.73). For Phang Nga Bay, the estimate was 850 Baht (USD 21.25) for partial damage to sandy beaches and 2,850 Baht (USD 71.25) for severe damage to sandy beaches.

Seenprachawong (2001) focused only on economic values of coral reefs in the Andaman Sea of Thailand. Phi Phi, the site analyzed, is rich in reefs and is envisioned as an ecological tourism destination by government planners. It has been found that Phi Phi provides large economic values through recreation. The consumer surplus estimated by a travel cost method reveals an annual value of 8,216.4 million Baht (USD 205.41 million). The study also employed a contingent valuation method to estimate both use and non-use values of Phi Phi's coral reefs representing an annual value of 19,895 million Baht (USD 497.38 million).

Each of the previous studies has particular limitations that affect the interpretation of the results. Although Sathirathai's study attempted to estimate the economic value of coastal resources, its findings did not include the non-use values. Moreover, the study did not address the complexities of the coastal ecosystems (i.e., the joint values of mangroves and coral reefs). Only mangrove ecosystems were emphasized. Likewise, Seenprachawong's study focused only on coral reefs ecosystems. Although Chuenpagdee's study incorporated ecological linkages among three coastal ecosystems (i.e. mangroves, sea-grass beds, and coral reefs), it did not give an estimate of total economic value of the whole ecosystems.

This research extends the previous research on economic valuation of coastal ecosystems in two ways. Firstly, it addresses the joint value of the coastal ecosystems. This study emphasizes two coastal ecosystems, mangroves and coral reefs, since they are often found together and may be closely linked. Economic values of changes to the quality of the joint habitats were estimated.

Secondly, this study uses a conjoint analysis to estimate the value of changes to the ecosystems. Conjoint analysis is a hedonic method that presents differentiated goods to people in terms of their attributes, and survey respondents are asked to evaluate assigned combinations of the attributes on a variety of scales. Conjoint response scales include rating each posited combination of attributes on a bounded, integer scale from very undesirable to very desirable, ranking alternatives from most desirable to least desirable, and choosing one of the specific alternatives. This study employs a choosing-one format, so called a choice experiment method.

5. Description of the Site

Phang Nga Bay can be considered as a protective area in terms of fisheries (fish and shrimp). Mariculture takes place along the bay coastal belt. The active areas are in Phang Nga and Krabi provinces. The sea surrounding Phi Phi Island, south of Lanta Island, and east of Yao Yai Island is found to be the spawning ground for mackerels. The aquaculture activities have been operating intensively in the 118 ha coastal area. The major operations, up to 85%, are found in Phang Nga province, with emphasis on shrimps and cockles. The minor operations are oysters and other bivalves, which produced a harvest of a few tonnes. Phang Nga Bay is blessed with distinctive and attractive tourism assets like beaches co-existing with good urban amenities in Phuket, and magnificent coastal views of Phang Nga and Krabi. Phuket's glory lies in its magnificent coastline. Beaches range from gentle crescents of white sands and calm waters to rocky headlands pounded by raging surf.

6. Methodology

The growing public interest in the management of coastal and marine environment in Thailand has presented coastal zone managers with the need to better understand public preferences. Table 1 shows an overview of stated preference elicitation methods used to elicit public preferences. Contingent valuation has traditionally been used to estimate the non-market value of environmental resources (Carson et al. 1995). Contingent valuation asks respondents' willingness to pay or to accept compensation for an environmental change in question. Contingent valuation evaluates the total economic value of single-attribute environmental goods. However, the value of each attribute cannot be distinguished using contingent valuation in multi-attribute environmental goods. Environmental economists have recently begun to pay attention to attribute-based methods, including rating-based conjoint analysis, ranking-based conjoint, and choice experiments, as new valuation techniques that can identify the value of each attribute of a multi-attribute environmental goods. A rating-based conjoint asks respondents to rate their preference among profiles on a scale. A ranking-based conjoint asks respondents to rank alternatives in order of preference from most desirable to least desirable. A choice experiment asks respondents to choose the profile they prefer most.

Table 1. Stated Preference Approach

Technique	*Description*
Contingent valuation (Single-attribute preference-elicitation)	Ask respondents their willingness to pay or willingness to accept compensation
Conjoint analysis (Multi-attribute preference-elicitation) • Rating-based conjoint Choice experiment (Or choice-based conjoint) Contingent ranking (Or ranking-based conjoint)	 • Ask respondents their preference on a rating scale (e.g., 1-6) • Ask respondents for their most preferred choice • Ask respondents to rank choices in order of preference

Boyle et al. (1997) have summarized five important issues regarding a debate over the relative merits of rating-based conjoint, choice experiment, and ranking-based conjoint. Firstly, there are researchers that advocate the use of ranking data because "values are often thought to be inherently comparative and competitive" (Rokeach 1973: p.6). Ranks are also consistent with ordinal interpretations of utility. A disadvantage of having respondents rank alternatives is that it is believed to be inherently more difficult and time consuming relative to rating alternatives. Secondly, the reliability of rank data declines with decreases in rank (Ben-Akiva et al. 1991). That is, individuals seem to provide better information about their most preferred alternatives and spending less cognitive efforts with lower rank alternatives. Thirdly, the relative ease of selecting ratings may reduce "respondents' willingness to make more precise distinctions about the relative importance of valued qualities" (Feather

1973: p.229). Fourthly, ratings allow a cardinal interpretation of utility on a bounded, integer scale (Roe et al. 1996). Specifically, the debate focuses on whether a ranking approach provides better data by forcing respondents to make distinctions across alternatives (like not allowing ties), or whether ratings - because ties are allowed - provide better data by allowing equal treatment of alternatives to which the respondents are indifferent. Fifthly, some have advocated a choice experiment since it is felt to mimic most closely actual choice behavior. One drawback with this approach is that it provides the least amount of information about preferences.

An attempt at valuing the characteristics of biodiversity within coastal ecosystem is a difficult task. Its dominant value arises out of ecological considerations not always reflected in market situations and the nature of interdependence between its components is ill defined. In valuing natural resource rich habitats, both in terms of their components and as parts of systems, the links between aggregation levels, nature of value associated with each component and approaches to valuation are of significance. This research used a choice experiment in valuing economic value of changes to the quality of coastal ecosystems in Phang Nga Bay. Conducting a choice experiment, we were able to calculate the estimates of value to quality changes of different ecosystem attributes in Phang Nga Bay. In a choice experiment, individuals were given a hypothetical setting and asked to choose their preferred alternative among several alternatives in a choice set, and they were usually asked to perform a sequence of such choices. Each alternative is described by a number of attributes or characteristics. A monetary value is included as one of the attributes, along with other attributes of importance, when describing the profile of the alternative presented. Thus, when individuals make their choices, they implicitly make trade-offs between the levels of the attributes in the different alternatives presented in a choice set.

The random utility model provides the theoretical framework for analyzing the data from the choice experiment exercise. The choice of an alternative (one of three scenarios in the choice experiment) represents a discrete choice from a set of alternatives.

According to this framework, each alternative is represented with the indirect utility function that contains two parts: a deterministic element (V_i) and a stochastic element (ε_i)-which represents unobservable influences on individual choice. The overall utility of alternative *i* is shown in equation (1).

$$U_i = V_i + \varepsilon_i \tag{1}$$

An individual will choose alternative *i* if $U_i > U_j$ for all $j \neq i$. However, since the utilities include a stochastic component, one can only describe the probability of choosing alternative *i* as

$$prob(i \ \ chosen) = prob(V_i + \varepsilon_i > V_j + \varepsilon_j ; \forall j \in C) \tag{2}$$

where C is the set of all possible alternatives. In the choice experiment, the V_i contains attributes of the situation and there are three alternatives (status quo, plan A, and plan B). McFadden (1974) showed that if the error terms in equation (2) independently and identically distributed (IID) with a type I extreme value distribution (a Gumbel distribution), then the probability of choosing alternative *i* has the following closed-form representation

$$prob(i) = \frac{e^{\lambda V_i}}{\sum_{j \in C} e^{\lambda V_j}} \tag{3}$$

This distribution is characterized by a scale parameter λ (which is inversely proportional to the variance of the error term) and a location parameter δ. In practice, the distribution chosen is the standard Gumbel distribution with λ=1 and δ=0 (Ben-Akiva and Lerman 1985). McFadden's model is known as the conditional logit model. There are two problems with the conditional logit model: (1) the alternatives are independent and (2) there is a limitation in modeling variation in taste among respondents.

The first problem arises from the IID assumption (constant variance), which results in the independence of irrelevant alternatives (IIA) property. This property states that the ratio of choice probabilities between two alternatives in a choice set is unaffected by changes in that choice set. If this assumption is violated, the conditional logit should not be used. One type of model that relaxes the homoskedasticity assumption of the conditional logit model is the nested logit model (McFadden 1978; Daganzo and Kusnic 1993). In this model the alternatives are placed in subgroups, and the variance is allowed to differ between the subgroups but is assumed to be the same within each group.

The second problem arises when there is taste variation among respondents due to observed and/or unobserved heterogeneity. Observed heterogeneity can be incorporated into the systematic part of the model by allowing for interaction between individual characteristics and attributes of the alternatives or alternative specific constants.

An estimated linear-in-parameters utility function for alternative *i* often takes the form:

$$V_i = \alpha_i + \sum_{j=1}^{n} \beta_j X_j + \sum_{k=1}^{m} \gamma_k \alpha_i Z_k \tag{4}$$

where α_i is an alternative specific constant, X_j is the ecosystem attributes associated with the alternative, Z_k is a vector representing individual characteristics and α_i, β_j and γ_k are parameters. Individual characteristics can be included in the model by interacting them with the alternative specific constants (as shown in equation (4)) and /or the attributes (not shown). All ecosystem attributes are entered the model using effect codes (the utility of the average quality level is the negative sum of the utilities of the good and excellent quality levels).

Welfare estimates are obtained in choice experiment studies, using the following general formula described by Hanemann (1984):

$$CV = \frac{1}{\mu}[\ln \sum_{i \in C} e^{V_{i1}} - \ln \sum_{i \in C} e^{V_{i0}}] \tag{5}$$

where μ is the marginal utility of income, V_{i0} and V_{i1} represent the indirect observable utility before and after the change under consideration, and C is the choice set. When the choice set includes a single before and after policy option, equation (5) reduces to:

$$CV = \frac{1}{\mu}[\ln e^{V_{i1}} - \ln e^{V_{i0}} l] = \frac{1}{\mu}[V_{i1} - V_{i0}] \quad (6)$$

From equation (6) it is easily seen that for a linear utility function, the marginal rate of substitution between two attributes is simply the ratio of their coefficients (Hensher and Johnson 1981), and that the marginal willingness to pay for a change in attribute is given by

$$MWTP_j = -\beta_j / \mu \quad (7)$$

7. Data Source

The data set used in this study was collected through questionnaires. It intends to estimate the value that resource users place on marine and coastal ecosystem quality changes. It is assumed that the current quality of ecosystems in Phang Nga Bay is at its average level (status quo). Respondents will be presented with two new management plans (plan A and plan B) which will protect endangered birds and other marine lives; maintain fish stocks; and improve recreational and educational facilities for residents and tourists. The plans will ensure that coastal ecosystems will be improved to higher quality levels (good and excellent). Each plan is defined using four ecosystem attributes: living coral cover (a proxy for recreational use), income from fishery (a proxy for consumptive use), flood occurrence (a proxy for indirect use), and area protected (a proxy for non-use value). The increase in income tax in 2002 is included as a WTP measure attribute, which will provide the link between the parameter weights of the ecosystem attributes (recreational use, consumptive use, indirect use, and existence value) and money.

The questionnaire was pre-tested using a payment ladder approach on 60 individuals to derive the implicit prices for each discrete change in marine ecosystem quality level. An example of a choice situation is presented in Table 2-A. Face-to-face interviews with individuals were conducted in two locations: Phang Nga Bay area (Phuket, Phang Nga, and Krabi Provinces); and other major provinces not in the Bay area. A payment ladder is a type of payment card, which sequentially lists a range of values from low to high. For each management plan, respondents were asked to tick the amounts they were sure they would pay and to cross amounts that they were sure they would not pay.

The payment ladder used in the pilot study is presented in Table 2-B. The values represent possibly an increase in income tax in 2002 to finance the Biodiversity Fund. Respondents were asked to begin with the lowest values and, considering each value in turn, they had to put a tick against those amounts that they were almost certain that they would be willing to pay. Respondents were then asked to consider the values at the high end of the ladder, and to cross those amounts that they were almost certain that they would not be willing to pay. In the example provided, the respondent is almost certain that he would be willing to pay as much as 250 Baht (USD 6.25) per year for plan A and 300 Baht (USD 7.5) per year for plan B, and equally certain that he would not be willing to pay as much as 750 Baht (USD 18.75) per year for plan A, and 1,000 Baht (USD 25) per year for plan B. Between these two values, the respondent was unable to mark either a tick or a cross, indicating that willingness to pay was uncertain over this range.

Table 2-A. Description of a Choice Situation

	Status quo	*Plan A*	*Plan B*
Increased living coral cover	No change	25 %	65 %
Increased income from fishery	No change	35 %	60 %
Flood occurrence	Every year	Every 2 years	Every 4 years
Increased area protected	No change	20 %	50 %

Table 2-B. Payment Ladder

Plan A			*Plan B*	
Baht	√, X		Baht	√, X
0	√		0	√
50	√		50	√
100	√		100	√
150	√		150	√
200	√		200	√
250	√		250	√
300			300	√
350			350	
400			400	
450			450	
500			500	
550			550	
600			600	
650			650	
700			700	
750	X		750	
800	X		800	
850	X		850	
900	X		900	
950	X		950	
1,000	X		1,000	X
1,100	X		1,100	X
1,200	X		1,200	X
1,300	X		1,300	X
1,400	X		1,400	X
1,500	X		1,500	X
1,600	X		1,600	X

1,700	X
1,800	X
1,900	X
2,000	X

1,700	X
1,800	X
1,900	X
2,000	X

Note: 40 Baht = 1 USD

The pre-test survey highlighted remaining problems in the wording of the questionnaire, the format used, and the choice of payment vehicle. In addition it allowed the testing of the visual aids. Key points resulting from the pre-test survey, that facilitated the design of an effective final survey instrument were (1) eliciting ranking was found to be more difficult than eliciting a single most preferred choice; (2) the design including dominated options to allow for rationality tests on consumers' choices was found to be difficult to understand by respondents, and so was dropped in the final survey; (3) the pre-test willingness to pay responses were used to define a choice experiment willingness to pay elicitation format to be used in the main survey.

The main sections of the questionnaire addressed: attitude towards the environment; current use of the mangroves and coral reefs; the choice experiment; and socioeconomic characteristics. The questionnaire and the attributes used in the choice experiment were developed in cooperation with researchers specialized in marine ecosystems from Marine Science Institute of University of the Philippines. Several focus group discussions and a pilot study were conducted in the process. In the introduction of the choice experiment, the purpose of Phang Nga Bay ecosystem valuation was briefly explained. The respondents were then informed about the particular coastal area in Phang Nga Bay that was about to be improved, and were informed that we were interested in their views on the best possible management plan. Next the attributes used in the choice experiment (see Table 3) were explained. The respondents were provided with a separate fact-sheet describing the attributes. Maps, text, graphics and concepts such as biodiversity, were used to communicate information on the mangroves and coral reefs of Phang Nga Bay. The current uses of the mangroves and coral reefs of Phang Nga Bay, its global importance as a habitat for rare and endangered birds, and the current threats the area is facing, were presented to respondents

The four ecosystem attributes were offered at three different levels (average, good, and excellent) and varied to reflect consistent ecological linkages. The cost variable varies between 200 Baht (USD 5) to 1,500 Baht (USD 37.5). In the choice experiment, each respondent answered four choice sets. The upper and lower bounds on the cost variable was identified in the piloting stages of the questionnaires; non-linear spacing of the fee levels ensured that choice experiment questions incorporated the maximum possible number of implicit price for each ecosystem quality levels. In each choice set respondents were asked to choose among three alternatives (see Table 4). The first alternative was always the base alternative, in which there would be no improvements to the Bay, at no cost. The two other alternatives implied a number of improvements to the Bay.

Table 3. Attributes and Attribute Levels

Attributes	*Level*
Increased living coral cover	Average (no change), Good (25%), Excellent (65%)
Increased income from fishery	Average (no change), Good (35 %), Excellent (60%)
Flood occurrence	Average (every year), Good (every 2 years), Excellent (every 4 years)
Increased area protected	Average (no change), Good (20 %), Excellent (50 %)
Increased income tax in 2002 (Baht)	0, 200, 700, 1000, 1500

Note: 40 Baht = 1 USD

Table 4. Example of a Choice Set from Phang Nga Bay Questionnaire

YOUR CHOICE ⇒			
	Status quo	*Plan A*	*Plan B*
Increased living coral cover	No change	25 %	No change
Increased income from fishery	No change	No change	60 %
Flood occurrence	Every year	Every 2 years	Every 4 years
Increased area protected	No change	20 %	50 %
Your increased income tax in 2002 (Baht)	0	200	700

Note: 40 Baht = 1 USD

To summarize the information in the data, effect codes were set up following Louviere (1988). Effect codes translate category-rating scales to a coding system that can be used in econometric analysis. The effect codes used in the econometric analysis for the flora and fauna attribute correspond to FFE (excellent flora and fauna), FFG (good flora and fauna), FFA (average flora and fauna, is the benchmark for comparison). The coefficients on FFE and FFG provide the “marginal utility” of these levels of the attributes, while –1 times the sum of these coefficients provide the “marginal utility” of the average level of flora and fauna. Effect codes for three other attributes (local livelihood, ecological function, and rare and endangered species) were coded in the same way (see table 5).

Table 5. Effect Codes for Ecosystem Attributes

Quality Level	FFE	FFG	LLE	LLG	EFE	EFG	REE	REG
Excellent	1	0	1	0	1	0	1	0
Good	0	1	0	1	0	1	0	1
Average	-1	-1	-1	-1	-1	-1	-1	-1

Note: EFA = Average Ecological Function

EFE = Excellent Ecological Function

EFG = Good Ecological Function

FFA = Average Flora and Fauna

FFE = Excellent Flora and Fauna

FFG = Good Flora and Fauna

LLA = Average Local Livelihood

LLE = Excellent Local Livelihood

LLG = Good Local Livelihood

The choice sets were created using the OPTEX procedure in SAS, which is a linear D-optimal design procedure (Kuhfeld 2001). The design is selected from the collective factorial, where collective factorial is a L^{AC} factorial, C is the number of alternatives and each alternative has A attributes with L levels. Using the OPTEX procedure we created 40 alternatives in the orthogonal design. A cyclical design is applied as an extension of the orthogonal approach. First, each of the alternatives in the orthogonal design is allocated to different choice sets. Attributes of the additional alternatives are then constructed by cyclically adding into the choice set based on the attribute levels.

Table 6. Orthogonal Design

Set	*Living coral cover*	*Fishery income*	*Flood Occurrence*	*Area protected*	*Cost (Baht)*
1	Good	Good	Good	Average	200
2	Good	Good	Excellent	Average	200
3	Good	Good	Average	Good	1000
4	Good	Good	Average	Excellent	1000
5	Good	Excellent	Good	Excellent	1500
6	Good	Excellent	Good	Excellent	700
7	Good	Excellent	Excellent	Good	1500
8	Good	Excellent	Excellent	Average	700
9	Good	Average	Good	Good	1000
10	Good	Average	Excellent	Good	1500
11	Good	Average	Average	Excellent	700
12	Good	Average	Average	Average	200
13	Excellent	Good	Good	Good	700
14	Excellent	Good	Good	Average	1500
15	Excellent	Good	Excellent	Excellent	1500
16	Excellent	Good	Excellent	Excellent	1000
17	Excellent	Good	Average	Average	1500
18	Excellent	Excellent	Good	Good	200
19	Excellent	Excellent	Good	Average	1000
20	Excellent	Excellent	Excellent	Good	700
21	Excellent	Excellent	Excellent	Average	200
22	Excellent	Excellent	Average	Good	1000
23	Excellent	Average	Good	Excellent	200
24	Excellent	Average	Excellent	Excellent	200
25	Excellent	Average	Average	Good	700
26	Excellent	Average	Average	Average	1500
27	Average	Good	Good	Good	1500
28	Average	Good	Good	Good	200
29	Average	Good	Excellent	Good	200
30	Average	Good	Excellent	Average	700
31	Average	Good	Average	Excellent	700

32	Average	Excellent	Good	Excellent	1500
33	Average	Excellent	Excellent	Average	1000
34	Average	Excellent	Average	Good	200
35	Average	Excellent	Average	Excellent	200
36	Average	Excellent	Average	Average	1500
37	Average	Average	Good	Average	1000
38	Average	Average	Good	Average	700
39	Average	Average	Excellent	Good	1500
40	Average	Average	Excellent	Excellent	1000

Note: 40 Baht = 1 USD

The attribute level in the new alternative is the next higher attribute level to the one applied in the previous alternative and if the highest level is attained, the attribute level is set to its lower level. These 40 choice sets were then blocked into 10 versions each containing 4 choice sets.

Ecosystem attributes were arranged into three hypothetical options for the respondents to elicit their most preferred choice. This information together with their most preferred choice indicates the relative importance among these ecosystem attributes and money. Socioeconomic characteristics of the respondents were included in the estimation and entered in the estimating equation interactively. The conditional logit model was used to analyze this choice experiment data and the unknown parameters were estimated by maximizing the likelihood function. This information was then used to calculate the value of each ecosystem attribute, which is essentially the marginal rate of substitution between ecosystem attribute and money.

Most of Phang Nga Bay benefits accrue at the local level (local livelihood) and national level (recreational values) and some at the global level (existence values). Therefore foreigners were excluded from the survey. The population sample was chosen from Thais between ages 18 and 75 years, living in and traveling to Phang Nga Bay area, a total of 2,555,703 persons. A sample of 300 individuals was randomly selected. The main survey was conducted from November 2001 to January 2002. Each individual answered four choice sets. Four teams of surveyors conducted face-to-face interviews. Each team consisted of two persons. A training course of two days was given in order to minimize biases due to misunderstanding of the questions by the interviewers. The training course consisted of a careful explanation of all questions, simulation of interviews among the surveyors and a pilot interview on an individual in order to check that the questions were clear enough to the respondents and that the time required to complete the interview were not too excessive. The initial survey and the main survey were divided into 4 trips, each trip lasting 5 days.

8. Empirical Results

Results for the conditional logit specifications with two different models: no interaction (Model 1) and with interaction (Model 2) are presented in Table 7.

Table 7 Estimation Results

	Model 1			*Model 2*		
Variable	*Coefficient*	*T statistic*	*P value*	*Coefficient*	*T statistic*	*P value*
Constant	0.801	5.268	0.000	-0.595	-1.008	0.313
Cost	-0.000541	-6.542	0.000	-0.000544**	-6.570	0.000

Good Flora and Fauna	0.149	2.859	0.004	0.144**	2.765	0.005
Excellent Flora and Fauna	0.230	4.408	0.000	0.236**	4.494	0.000
Good Local Livelihood	0.142	2.716	0.006	0.140**	2.684	0.007
Excellent Local Livelihood	-0.025	-0.499	0.617	-0.025	-0.490	0.624
Good Ecological Function	0.074	1.415	0.157	0.075	1.432	0.152
Excellent Ecological Function	0.137	2.674	0.007	0.137**	2.672	0.007
Good Rare and Endangered species	-0.112	-2.156	0.031	-0.111**	-2.128	0.033
Excellent rare and Endangered species	0.085	1.619	0.105	0.086*	1.630	0.103
Age				0.005	0.449	0.653
Inc				0.000005	0.489	0.624
Male				0.0064	0.038	0.969
Single				0.365*	1.788	0.073
Nedu				0.062**	2.349	0.018
Hnum				0.029	1.039	0.299
Log-likelihood	-1,147.17			-1,141.46		
No. of respondents	300			300		
No. of observations	1,200			1,200		

** Significant at 5 %

* Significant at 10 %

Both models include one common alternative specific constant for the two alternatives that imply quality improvement of Phang Nga Bay ecosystem, i.e. the non-status quo alternatives, since these were presented in a generic form. An increase in the log-likelihood function indicates the advantage of applying Model 2. All ecosystem attributes except for “excellent local livelihood” and “good ecological function” are significant. These attributes are also insignificant in Model 1. The mean coefficient is negative for “good rare and endangered species”, so a majority of respondents dislike this attribute. Among the socio-characteristics, both single and higher educated person is more likely to choose an improved Phang Nga Bay ecosystem.

The interpretation of the coefficient values is not straightforward, except for the significance and relative size. It is meaningful to compute the marginal rates of substitution between the attributes using the coefficient for the cost as numeraire. This implies that one can interpret the ratios as average marginal WTP for a change in each attribute, as argued by Hanemann (1984). The results are presented in Table 8.

Table 8 Marginal WTP for a Change in Each Attribute

	(Baht/person/year)		
Attributes \ Quality Level	*Average*	*Good*	*Excellent*
Flora and fauna	-699	265	434
Local livelihood	-257	257	-
Ecological function	-252	-	252
Rare and endangered species	46	-204	158

Note: 40 Baht = 1 USD

Using equation (6) to estimate the welfare implications of moving from status quo (average) to non-status quo (good and excellent) produces mean welfare estimates (compensating variation-CV) as shown in Table 13. The numbers are computed as follows.

CV for improving flora and fauna from average to excellent = 434 - (-699) = 1,133

CV for improving local livelihood from average to good = 257 - (-257) = 514

CV for improving ecological function from average to excellent = 252 - (-252) = 504

CV for improving rare and endangered species from average to excellent = 158 - 46 = 112

The welfare estimates of improving Phang Nga Bay ecosystem as shown in Table 9 indicates that diversity of flora and fauna, which provides recreational and tourism benefits is the most important attribute of Phang Nga Bay. The welfare estimate indicates that an individual is willing to pay 1,133 Baht (USD 28) per year for improved diversity of flora and fauna in Phang Nga Bay. Local livelihood (e.g. income from fishery) and ecological function (e.g. flood protection benefits) are equally important attributes of Phang Nga Bay (Figure 3). The rare and endangered species attribute is the least important attribute of Phang Nga Bay. The aggregate benefits in this report were computed by multiplying numbers of people in the beneficiary groups[2] with welfare estimate of improving Phang Nga Bay ecosystem - 2,263 Baht (USD 57) per person, yielding 5,784 million Baht (USD144.6 million) per year.

Table 9. Welfare Estimates of Moving from Status Quo to Non-status Quo

Attributes \ Welfare estimates	*WTP to improve Phang Nga Bay Baht (USD)/person/year*	*Percentage (%)*

[2] The number of people in beneficiary groups was taken from National Statistical Office, 1999. The groups included 348,369 adjacent dwellers, 133,767 tourism operators, and 2,037,567 tourists.

Flora and fauna (direct use values e.g. recreation and tourism)	1,133[a] (28)	50
Local livelihood (direct use values e.g. fishery income)	514[b] (13)	22
Ecological function (indirect use values e.g. flood protection)	504[c] (13)	22
Rare and endangered species (non- use values)	112[d] (3)	6
Total	2,263 (57)	100

[a] welfare estimate of moving from average to excellent was selected for flora and fauna

[b] welfare estimate of moving from average to good was selected for local livelihood

[c] welfare estimate of moving from average to excellent was selected for ecological function

[d] welfare estimate of moving from average to excellent was selected for rare and endangered species

9. Conclusions and Policy Recommendations

This study uses a choice experiment to value coastal ecosystems in Phang Nga Bay. The advantages of the choice experiment are that values for each attribute as well as marginal rate of substitution between non-monetary attributes can be estimated. The success of the choice experiment depends on the design of the experiment, which is a dynamic process. It involves definition of attributes, attribute levels and customization, context of the experiment, experimental design and questionnaire development. Through the pre-test survey process it was possible to put to rest a number of concerns over the feasibility of the choice experiment approach as a valuation technique at the chosen site. The early drafts of questionnaire were carefully discussed with marine scientists. Considerable attention was paid to the wording of ecological attributes occurring in the questionnaire, in an effort to ensure that these could be easily followed and understood by respondents. There were ten ecosystem attributes in the original design. These were narrowed down to four since this is the number which most respondents can deal with. The survey instruments had been largely modified after the focus groups and pre-tests. During the course of the pre-test survey, visual aids (maps, texts, and graphics) appeared to be an effective means of communicating information, and they were consequently heavily relied upon in the main survey. The quality of the photographs plays an important role in communicating information on the mangroves and coral reefs of Phang Nga Bay. During the main survey, respondents were able to understand hypothetical situations and were very cooperative.

The welfare gain of improving recreational and tourism attribute in Phang Nga Bay was estimated to be 1,133 Baht (USD 28) per person per year. By capturing a portion of this welfare gain, the park can finance management activities to protect and restore its mangrove forests and coral reefs, as well as fulfil broader social objective of providing for scientific research and education. To get an optimal entrance fee to the park, it will need the underlying theory for the optimal pricing of protected areas used in recreational activities, from the perspectives of a park authority interested in welfare maximization. Hence, the welfare estimates derived from this research is not sufficient for setting the optimal entrance fee for the park.

Examples of benefit capture mechanisms to finance marine park management can be found in other marine protected areas within the wider Caribbean (Gustavson, 2000) which include park entrance fees, user fees and earmarked portions of departure taxes.

Based on the existing benefit capture mechanisms to finance marine protected area management in the Caribbean, it is recommended that the Thai government introduce a two-tiered basic entrance fee for marine parks in Phang Nga Bay, with different rates for residents and foreigners[3]. Thais pay an entrance fee of 40 Baht (USD 1)[4] while foreigners pay 400 Baht (USD 10)[5]. This practice both captures sizeable amounts of rent to help pay for the management of the park system, and also recognizes the income differences between residents and foreigners. Supplementary user fees should also be levied when visitors receive additional services from the variety of recreational sites on offer in Phang Nga Bay. It would seem reasonable for the park to impose charges for tourists visiting certain special and ecologically sensitive areas. For example, after having charged a basic entrance fee, the park could impose a diving fee of 200 Baht (USD 5) per person per visit if the visitor chooses to dive in the Coral Island. This user charge would help raise additional revenue for the park by transferring economic rents from high-end consumers to gains, while leaving the low-income visitors unaffected.

The use of a hotel room tax can also be implemented. This is preferred since the tax is proportional to resource use. Given the inelastic nature of the demand, the impact on the bottom line for hotel operators is likely to be modest. Earlier prediction (Comb and Elledge 1979) indicated that demand is expected to be inelastic, meaning that a small addition room tax would not substantially affect accommodation business levels. Hiemstra and Ismail (1992) found that the demand for more expensive rooms was more elastic (-0.35 for the least expensive category of room versus –0.57 for the most expensive category of room).

It is recommended that a room tax of 40 Baht (USD1) per bed-night be imposed. This tax should be reduced or waived for Thais. Finally, it is a question of marketing. Brochures can be provided to arriving tourists explaining the sensitive nature of the Phang Nga Bay that they will be enjoying, and the need to fund the care and preservation of this beautiful bay. Instead of a ‘lodging tax’ on the hotel bill, a ‘resource conservation fee’ might be more acceptable to the tourist. The key point is that the tax should not be perceived as something designed to discriminate against foreigners, but rather as a user fee for the enjoyment of the environment. The rents collected can be shared between earmarked activities (environmental resource management, trash collection, coastal patrolling, etc.) and general revenues for the

[3] There is a certain logic to this. Foreigners do not pay income tax or business tax to the local government. They take the extra benefit from the use of the resource home with them when they leave. As such, failing to charge higher user fees on foreign visitors implies that the country is subsidizing an increase in the social welfare of the visitors from richer countries.

[4] Entry fees for marine parks in Phang Nga Bay have traditionally been very low. At the time of this study (2002), a basic entrance fee of 20 Baht (USD 0.50) is charged per person.

[5] Earlier studies on Phi Phi Island (Seenprachawong 2001) indicated that the annual consumer surplus as estimated by the travel cost method was in the magnitude of 10 to 1 (USD 2010 for each foreign visitor and USD184 for each Thai visitor).

national treasury (for example, a statement that 60% of room tax goes to resource management or pollution control). In cases where a division of the revenues is not possible, it may be necessary to create a separate entity to collect and manage funds, and in some cases to help provide management services.

REFERENCES

Ben-Akiva, M. and S.R. Lerman 1985. **Discrete Choice Analysis: Theory and Application to Travel Demand**. MIT Press, Cambridge.

Ben-Akiva, M., T. Morikawa, and F. Shiroishi 1991. Analysis of the Reliability of Preference Ranking Data. **Journal of Business Research**. 23: 253-268.

Boyle, K.J., T.P. Holmes, M.F. Teisl, B. Roe, S. Phillips, and G. Pullis. 1997. Public Preferences for Timber Harvesting Using Conjoint Analysis: A Comparison of Response Formats. **Working Paper**, University of Maine. USA.

Carson, R.T. et al. 1995. **A Bibliography of Contingent Valuation Studies and Papers**., CA. San Diego: Natural Resource Damage Assessment, Inc.

Chuenpagdee, R. 1998. Damage Schedules for Thai Coastal Areas: An Alternative Approach to Assessing Environmental Values. **Economy and Environment Program for Southeast Asia**, Singapore.

Comb, J.P. and B.W. Elledge 1979. Effects of a room tax on resort hotel/motels. **National Tax Journal** 32:201-207.

Daganzo, C.F., M. Kusnic 1993. Two properties of the nested logit model. **Transportation Science** 27, 395-400.

Ellis, G. M., and A. C. Fisher .1987. Valuing the Environment as Input. **Journal of Environmental Economics and Management**. 25: 149-56.

Feather, N.T. 1973. The Measurement of Values: Effects of Different Assessment Procedures. **Australian Journal of Psychology**. 25: 221-231.

Freeman, III, A.M. 1991. Valuing environmental resources under alternative management regimes. **Ecological Economics**. 3: 247-256.

Gustavson, K. 2000. **Capturing Coral Reef Benefit Values- Financing Marine Environment Conservation in Montego Bay, Jamaica**. The World Bank, Washington, D.C.

Hanemann, M. 1984. Welfare evaluations in contingent valuation experiments with discrete responses, **American Journal of Agricultural Economics** 66: 332-341.

Hensher, D.A. and L.W. Johnson 1981**. Applied Discrete Choice Modeling**. John Wiley, New York. pp. 468.

Hiemstra, S.J. and J.A. Ismail 1992. Analysis of room taxes levied on the lodging industry. **Journal of Travel Research** 31(1): 42-49.

McFadden, D. 1974. **Conditional Logit Analysis of Qualitative Choice Behavior, Frontiers in Econometrics**, (P. Zarembka ed.) Academic Press, 105-142.

McFadden, D. 1978. Modeling the choice of residential location. In: Karlquist, A., L. Lundquist, F. Snickers, J.W. Weibull (Ed), **Spatial Interaction Theory and Planning Models**. North-Holland, Amsterdam, pp. 75-96.

Roe, B., K.J. Boyle, and M.F. Teisl 1996. Using Conjoint Analysis to Derive Estimates of Compensating Variation. **Journal of Environmental Economics and Management.** Vol.31(2), pp. 145-159.

Rokeach, M. 1973. **The Nature of Human Values**. New York: Free Press.

Sathirathai, S. 1998. Economic Valuation of Mangroves and the Roles of Local Communities in the Conservation of Natural Resources: Case study of Surat Thani, South of Thailand. **Economy and Environment Program for Southeast Asia**, Singapore.

Seenprachawong, U. 2001. An Economic Analysis of Coral Reefs in the Andaman Sea of Thailand. (forth coming) **Economy and Environment Program for Southeast Asia**, Singapore.