Economic Valuation of Ecosystem Benefits:

an Application to Coral Reefs in Ras Mohamed National Park

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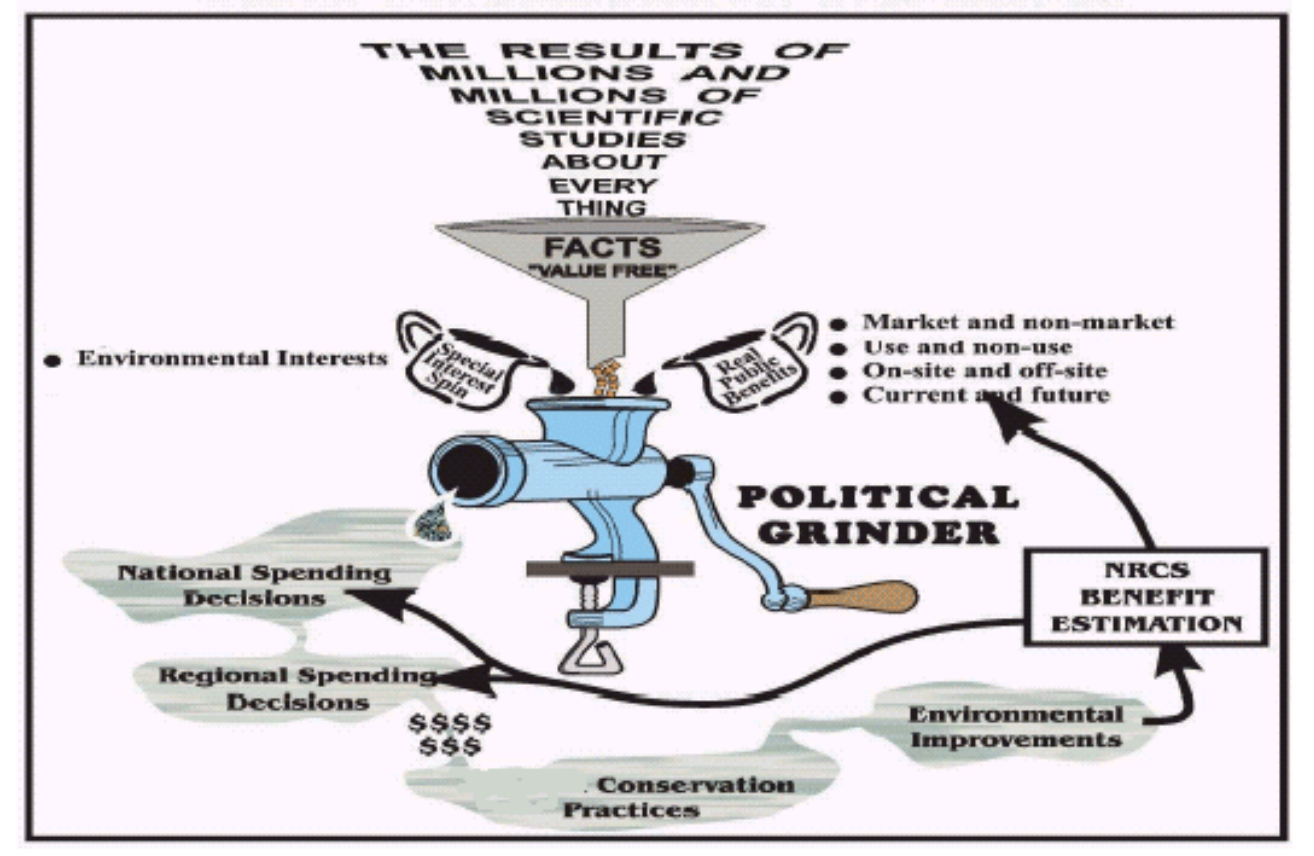
Our ancestors appreciated nature's services in a time in which these services were abundant and human-made capital was the limiting factor in economic development. The ancient Egyptians, for example, believed that all is connected and nature and culture existed in a beneficial equilibrium, in harmony (which was called Maat). All things should be kept the way it was once created in order to protect happiness and welfare for all. Contemporary society has failed to give such appreciation to these services despite the fact that remaining natural capital has become the limiting factor.

We often keep saying that we are doing a lot, while doing little. One main reason for this negligence is a failure to realise the full value of beneficial services provided by nature.

The concept & importance

- As long as we make choices about ecosystem services and cannot find a "win-win" solution, we need valuation.
- Most of environmental decisions require weighing the different aspects of the decision problem. Such relative weights given to the problem aspects imply valuations.
- This inherence link between decisions and valuation makes the latter not optional.



- The term of value generally means desirability or importance.
- It has a range of meanings in different disciplines.
- Many studies have linked between the concept of value and the aim of valuation, e.g. the ecological value and sustainability, the economic value and the efficiency, and the socio-cultural value and the equity and cultural perceptions.
- Farber et al. (2002) defined valuation as the process of expressing a value of an action or object.
- Economic valuation can help to:

  - increase awareness
  - penalise environmentally degrading activities
  - incentivise sustainable uses
  - raise funds for conservation

kvams.wordpress.com

economic information is likely to be more influential in real policy-making situations than ecological information

Economic Reasons for Maintaining Ecosystem Services

- Balmford et al. (2002) estimated the required cost of a reserve system meeting minimum safe standards (covering 15% and 30% of land and sea area respectively) to be around $45 billion per year while the benefits of the ecosystem services were between $4,400 billion and $5,200 billion per year presenting a benefit : cost ratio around 100:1.

- Costanza et al., (1997) estimated the annual value of nature's services to be between $16 trillion and $54 trillion, with an average of $33 trillion per year.

articles

The value of the world's ecosystem services and natural capital

Robert Costanza*†, Ralph d'Arge‡, Rudolf de Groot§, Stephen Farber‖, Monica Grasso†, Bruce Hannon¶, Karin Limburg#*, Shahid Naeem**, Robert V. O'Neill††, Jose Paruelo‡‡, Robert G. Raskin§§, Paul Sutton‖‖ & Marjan van den Belt¶¶

Coral Reef Unit Value $ ha-1 year-1

A literature review was carried out and 66 value observations for the different benefits provided by coral reefs were synthesised

	Mean	Median	Minimum	Maximum	Midpoint	Cases
Production Services						
fishery	537	111	1	3,946	1,974	10
aquarium trade	10	10	10	10	10	1
Seaweed farming	73	73	73	73	73	1
ornamental goods	1	1	1	1	1	1
Mining	2193	2193	155	4231	2,193	2
construction materials	9	9	9	9	9	1
Pharmaceuticals	65,551	65,551	65,551	65,551	65,551	1
	68,374	**67,948**	**65,800**	**73,821**	**69,811**	**17**
Cultural Services						
recreation	83,645	1,440	4	948,985	474,495	26
education and research	32	28	2	68	35	4
option and existence	33	33	33	33	33	1
artistic inspirational value	1	1	1	1	1	1
spiritual value	1	1	1	1	1	1
Aesthetic value	64	64	64	64	64	1
Amenity value	274	274	274	274	274	1
non-use value	16,751	9,276	48	56,893	28,471	5
	100,801	**11,117**	**427**	**1,006,319**	**503,373**	**40**
Regulation Services						
coastal protection	41,525	7,986	186	195,822	98,004	6
waste assimilation	99	99	99	99	99	1
refuge	12	12	12	12	12	1
biodiversity maintenance	8	8	8	8	8	1
	41,644	**8,105**	**305**	**195,941**	**98,123**	**9**
	210,819	**87,170**	**66,532**	**1,276,081**	**671,307**	**66**

Tawfik, 2010

what is being valued

- Economic valuation derives the change ecosystem service makes to human well-being. It has to be made in the context of benefits already (or will be) available to individuals.

- What is being valued is neither the ecosystem per se nor the services but rather the benefits provided by them.

- This does not mean that ecosystems and their services are not valuable but there is a difference between being valuable and being valued.

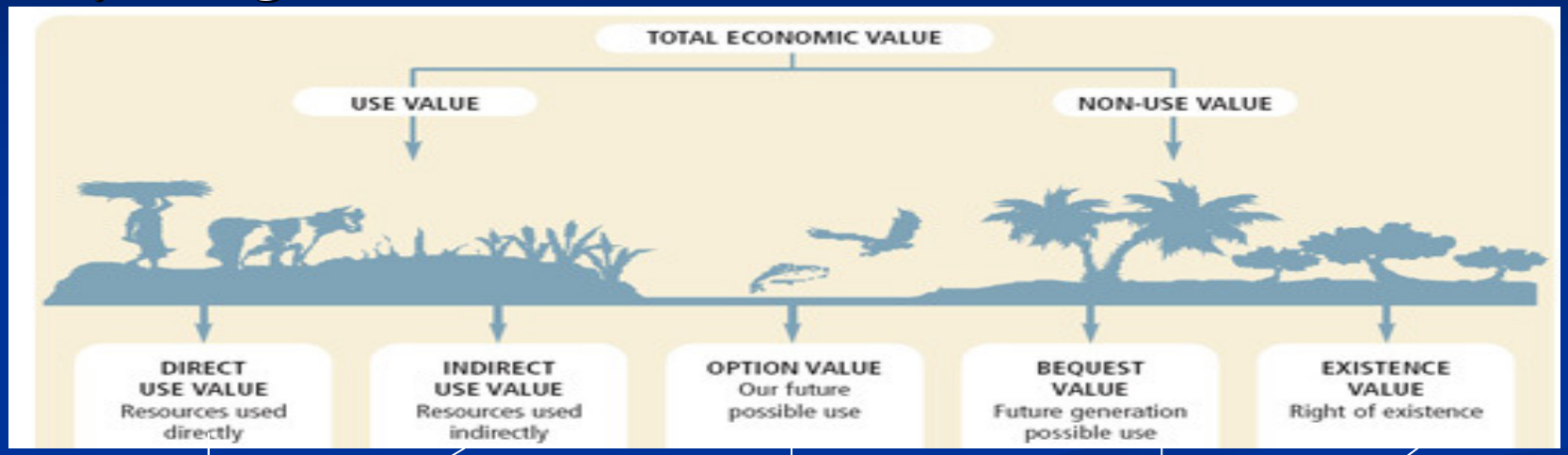
- Terminology is a significant part of the valuation problem (Boyd, 2007).

- According to Fisher et al. (2009) ecosystem services are "the aspects of ecosystems utilised, actively or passively, to produce human well-being".

- The final services in combination with other forms of capital provide benefits (e.g. the diversity of flora and fauna, clear warm, surroundings, access, boats, diving and snorkelling equipments, individual skills and time allocation are means used by reef visitors to yield recreational benefits).

Total Economic Value (TEV)

- Economists assign several types of values to ecosystem benefits.
- Some of these values are easy to identify and others are either unknown or very intangible.



Direct use values stem from human direct interaction with or utilisation of ecosystem services

indirect use values emanate from indirect utilisation of ecosystem services

Option values arise from uncertainty about the future and the desire of keeping open the option of utilising certain service in the future

Non-use values can be divided into:

- existence value (stewardship motivation) - bequest value (intergenerational altruism)

- altruistic value (intragenerational altruism).

Decreasing "tangibility" of value to individuals / Increasing Difficulty of Valuation

Different Types of Values

types of values	*examples*
Direct use value (extractive)	• Food/other resources (fishery) • Construction material • Pharmaceuticals and other industrial chemicals
Direct use value (non-extractive)	• Tourism and recreation • Education and scientific interest
Indirect use values	• Biological support • Coastal protection
Non-use values	• Genetic resources • Known and unknown future uses of the functions above

Source: Spurgeon, 1992.

Valuation Methods

- The main challenge faces economic valuation of ecosystem outcomes is that many of these outcomes are not valued on markets.

- A range of valuation methods can be applied to capture the different types of values of ecosystem benefits such as stated preference methods, revealed preference methods, and cost-based methods.

- Choice of valuation technique generally depends on the imapct to be valued and the availability of resources, time and data for the study.

Category of technique	Name of Technique	Description of approach
Market price based	**Market values**	Value based on market prices and taking into account any artificial Government intervention such as taxes and subsidies.
Output based	**Change in productivity**	Value is based on the change in quality and/or quantity of a marketed good and the associated change in total net market value (e.g. measuring fishery support function).
	Dose-Response	An environmental change is linked with a change in production
	Expected values	Value is based on potential revenues (less potential production costs) multiplied by probability of occurrence.
Cost based	**Damage costs avoided**	Value of an asset is equivalent to the value of the economic activity or assets that it protects (e.g. the damages avoided by maintaining a coast protection function)
	Replacement cost	Value is based on the cost of replacing the environmental function.

Category of technique	Name of Technique	Description of approach
Revealed Preference / Implicit or Surrogate Market *(uses market based information to infer a non-marketed value)*	**Travel cost method**	Value can be inferred from the cost of travel to a site (i.e. expenses and value of time) using regression analysis.
	Hedonic price	Value of goods is based on the value of individual components (e.g. the landscape premium of property prices) which can be determined through regression analysis.
Stated Preference/ Construed market approach *(questionnaire surveys to ask people's direct willingness to pay or accept)*	**Contingent valuation**	Carefully constructed and analyzed questionnaire survey technique asking representative sample of individuals how much they are willing to pay to prevent loss of, or enhance an environmental good or service or willing to accept compensation for environmental costs
	Choice experiments	As above, but by asking respondents to select their preferred package of environmental goods at different prices and then inferring specific component values via econometric analysis.
Transfer of Values	**Benefits (Value) Transfer**	The transfer of economic values estimated in one context and location to estimate values in a similar or different context and location.

Source : Belli et al., 2001

Recreational Value of Coral Reefs

A Case Study of Ras Mohammed National park

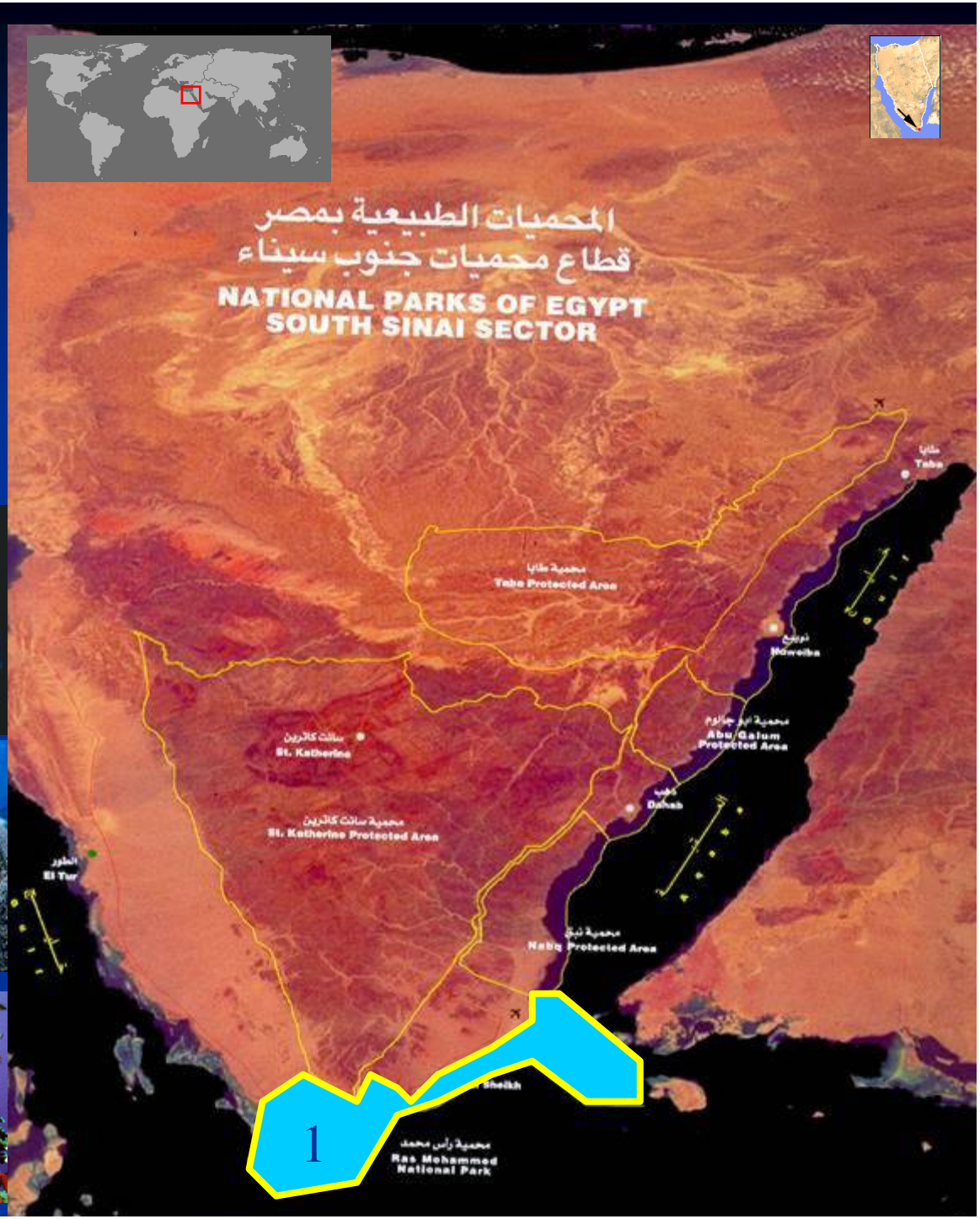
NATIONAL PARKS
OF EGYPT

جهاز شئون البيئة

Ras Mohammed declared in 1983 and covering an area of 460 km^2.

the park is home to some of the most spectacular coral reefs in the world.

1. Ras Mohammed National Park

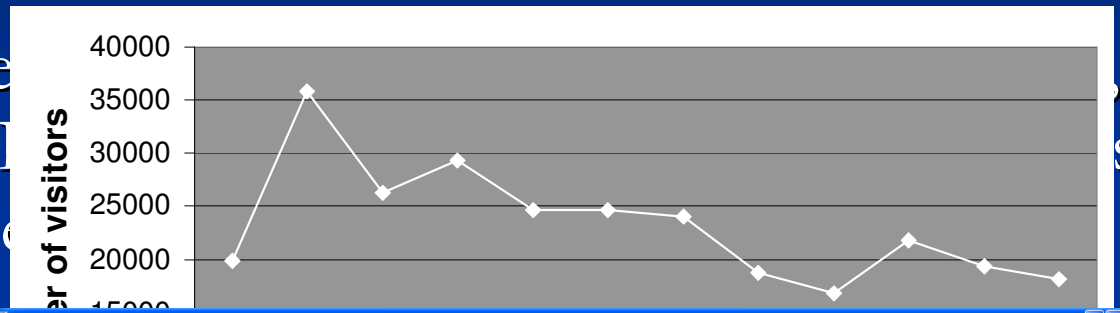


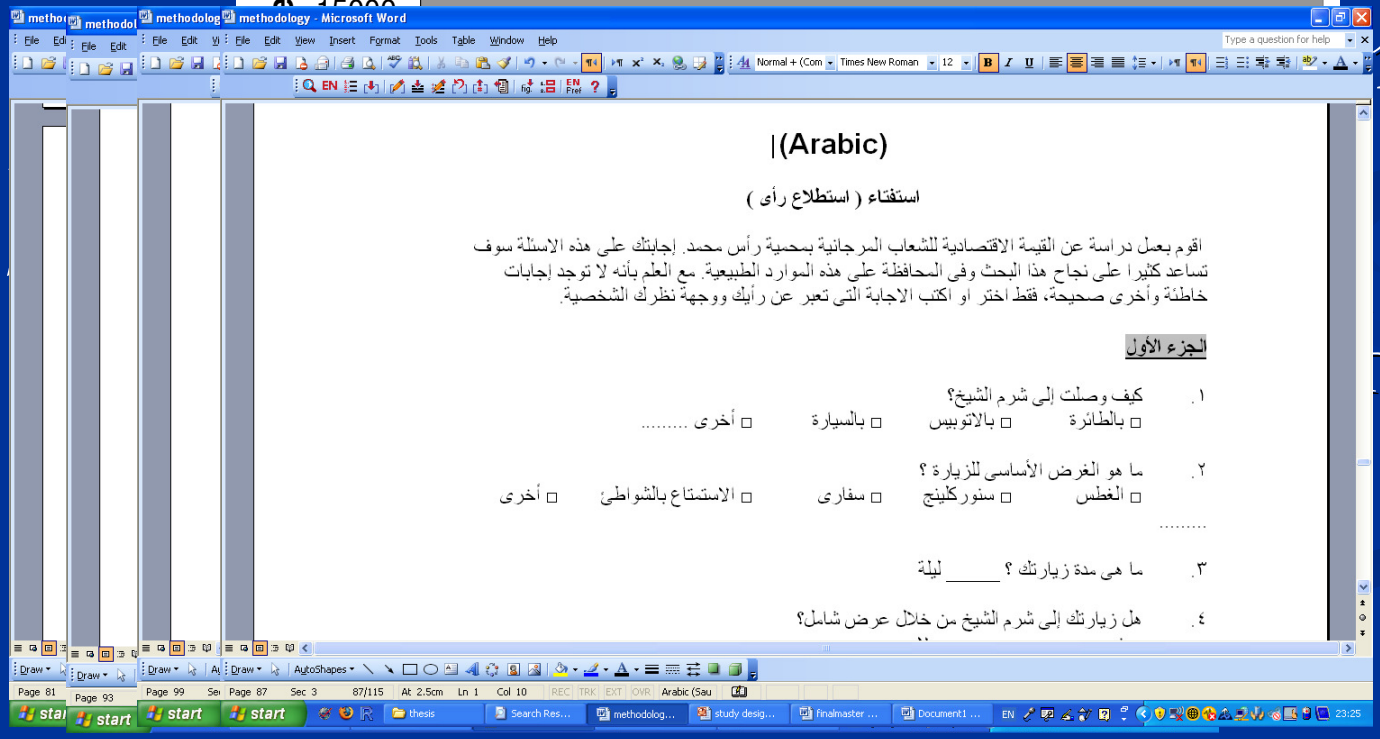
Why Recreation

- Recreational benefits were thought to be the most important to the different stakeholders.
- Recreation is often cited as the most significant economic benefit of coral reefs and the recreational value can be used as a lower bound of the reefs' value.
- Coral reef tourism in South Sinai is the pillar of the local economy.
- Valuing one or a few benefits may be sufficient to make more plausible picture than trying to measure everything… though we must not lose sight of the fact that they are only part of the whole.

Data

- The survey was conducted between March and August of 2003 & 2008.
- Because , English, Italian, stionnaire were use
- 1,200
- that Tourists





|(Arabic)

استفتاء (استطلاع رأى)

اقوم بعمل دراسة عن القيمة الاقتصادية للشعاب المرجانية بمحمية رأس محمد. إجابتك على هذه الاسئلة سوف تساعد كثيرا على نجاح هذا البحث وفى المحافظة على هذه الموارد الطبيعية. مع العلم بأنه لا توجد إجابات خاطئة وأخرى صحيحة، فقط اختر او اكتب الاجابة التى تعبر عن رأيك ووجهة نظرك الشخصية.

الجزء الأول

١. كيف وصلت إلى شرم الشيخ؟
□ بالطائرة □ بالاتوبيس □ بالسيارة □ أخرى .....

٢. ما هو الغرض الأساسى للزيارة ؟
□ الغطس □ سنوركلينج □ سفارى □ الاستمتاع بالشواطئ □ أخرى
.....

٣. ما هى مدة زيارتك ؟ _____ ليلة

٤. هل زيارتك إلى شرم الشيخ من خلال عرض شامل؟

1) Zonal Travel Cost Model (ZTCM)

The ZTCM divides the area surrounding the site into zones. So the unit of observation is the zone. The number of visits per capita from each zone as a function of the travel cost.

$$Vi = V(Ci, POPi, Si)$$

where Vi is visits from Zone i to the Ras Mohammed; POPi is the population of Zone i and Si are socio-economic variables.

Three types of travel-related costs were included:

1) transportation costs: Because most visitors to Sharm El-Sheikh come by plane, we simply measured the cost of a round trip economy ticket

2) travel time: we assumed the travel time costs of one-third of the wage rate.

3) local expenditures.

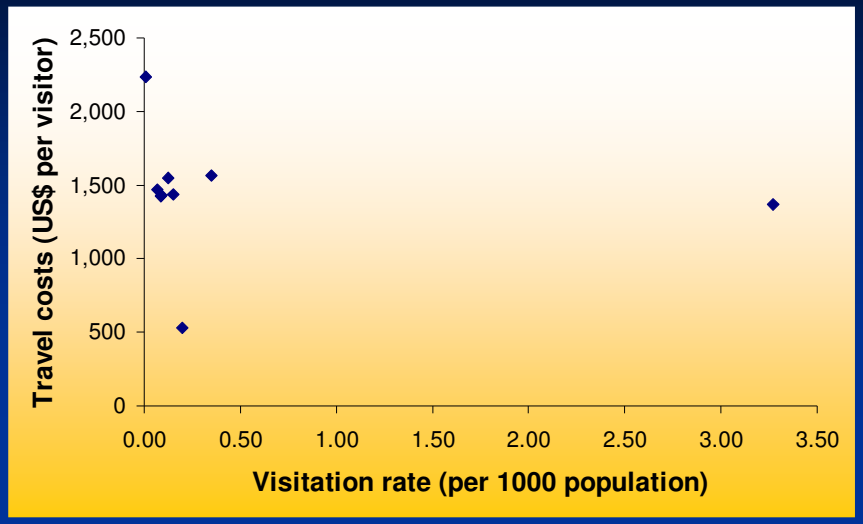
Visitation rate per 1000 of the population

Region	Population[3]	Visitor	Visitation Rate
Egypt	76,117,421	15050	0.20
Italy	58,057,477	189,915	3.27
France	60,424,213	5,262	0.09
UK	60,270,708	5,574	0.09
Germany	82,424,609	5,838	0.07
Netherlands	16,318,199	2,453	0.15
Scandinavia	19,268,318	2,376	0.12
Russia	143,782,338	50,269	0.35
US	293,027,571	2,563	0.01

Travel-related costs of visitors

Region	Travel costs	Time costs[4]	Other costs	Total
Egypt	50	25	455	530
Italy	400	161	910	1,471
France	450	166	910	1,526
UK	450	169	910	1,529
Germany	500	162	910	1,572
Netherlands	450	175	910	1,535
Scandinavia	550	189	910	1,649
Russia	600	58	910	1,568
US	1,300	227	910	2,437

graphical relationship between the visitation rate and travel cost



LN(visitation rate) = 0.68726 – 0.00173 travel costs

Consumer Surplus

Region	Consumer Surplus	Price Paid
Egypt	34,402,302	7,980,681
Italy	4,887,254	279,376,043
France	4,597,000	8,028,672
UK	4,559,974	8,521,371
Germany	5,754,171	9,177,336
Netherlands	1,221,324	3,764,369
Scandinavia	1,163,149	3,919,210
Russia	10,118,743	78,805,967
US	3,360,066	6,244,987
Total	**70,063,983**	**405,818,635**

$$CS = \sum_{i=1}^{n} \left\{ \frac{population_i}{\beta_1} \exp^{\beta_0} \left[\exp(\beta_1 P^*) - \exp(\beta_1 travel\,costs_i) \right] \right\}$$

- The total recreational benefit is estimated to be over US$ 475 million per year.
- From the survey, it was determined that the importance of reefs in the visitors overall experience was on average 30%.
- The total reef-associated recreational value of over US$ 142 million.

2) Individual Travel Cost Model (ITCM)

The individual's recreational value is estimated by the area under his demand function. So the total recreational value of the site is calculated by integrating the demand function of each individual.

$$V_i = f(TC_i, S_i)$$

where Vi is number of visits made by individual i in a year; TCi is travel cost of individual i and Si represents other factors determining the individual's demand for visits to the park.

we use the semi–log form. The logarithm of the dependent variable helps to adjust its skewness to normal distribution.

$$\text{Ln } V_i = a + bTC_i + cS_i + \varepsilon_i$$

All results based on nonmissing observations.

Variable	Mean	Std.Dev.	Minimum	Maximum	Cases
N_VISITS	2.22471910	4.85671021	1.00000000	55.0000000	178
TCM	1522.91976	854.011514	250.000000	3994.00000	178
SUB	.629213483	.484377928	.000000000	1.00000000	178
INCOME	1964.60674	2922.25004	50.0000000	12500.0000	178
MALE	.601123596	.491048545	.000000000	1.00000000	178
AGE	31.9943820	9.15682401	15.0000000	59.0000000	178
EDUCATIO	14.0449438	3.20278873	6.00000000	20.0000000	178
FAMILY	3.93258427	2.27637214	2.00000000	10.0000000	178
CERT	.511235955	.501283821	.000000000	1.00000000	178
SKILL	2.56179775	.996661729	.000000000	4.00000000	178
INFO	2.62359551	.842986683	1.00000000	4.00000000	178

Consumer Surplus per-visit

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]
Fncn(1)	758.7327967	92.375994	8.214	.0000

- The recreational benefit per visit, which is calculated by summing up the consumer surplus per visit and the average travel cost per visit, is US$ 2,280.

- Based on the total number of visits to Ras Mohammed, the total recreational benefit is estimated to be above US$ 636 million per year.

- The reef-associated recreational value, therefore, is about US$ 191 million per year.

3) Contingent Valuation

"Reality often counts for little, perceptions count for everything" (Hensher et al., 2005).

- To isolate the consumer surplus associated with visits to the coral sites alone, a CVM study was conducted that focused on those who visited the reef sites only.

- The maximum WTP is modeled as a function of income, gender, age, level of education, family size, diving certification, snorkeling skills, information about corals and coral reefs status.

- To avoid non-response and the starting point bias problems, we used payment card method in the questionnaire .

- The crucial valuation question was: "What is the maximum you would be willing to pay on top of the existing entrance fee to support coral reefs conservation?". The listed values were $1, $3, $5, $10, $10+.

$E[y_i \mid x_i] = \beta' x_i$

WTP = 0	$y_i = 1$	if $y_i^* < 1$
WTP = 1	$y_i = 2$	if 1 ? $y_i^* < 3$
⋮		
WTP = 5	$y_i = 4$	if 5 ? $y_i^* < 10$
WTP = 10+	$y_i = 5$	if 10 ? y_i^*

OLS Midpoint, Tobit and Grouped Data Estimates

Variable	OLS	TOBIT	Grouped Data
Constant	5.946949108	5.946949108	3.137791107
	(2.6963454)	(2.6117028)	(3.7247938)
INCOME	.1465576613E-03	.1465576613E-03	.1935428893E-03
	(.13336259E-03)	(.12917612E-03)	(.18103555E-03)
SUB	-.6605555688	-.6605555688	-.7405515368
	(.81104219)	(.78558228)	(1.1167227)
MALE	-.2553337256	-.2553337256	-.2062828063
	(.78296779)	(.75838918)	(1.0736837)
AGE	.3701629363E-01	.3701629363E-01	.5883314435E-01
	(.42899028E-01)	(.41552359E-01)	(.59114326E-01)
EDUCATIO	-.2694096104	-.2694096104	-.3254547147
	(.11889189)	(.11515969)	(.16328722)
FAMILY	.1908368896	.1908368896	.2731913625
	(.16879836)	(.16349951)	(.23344870)
CERT	.6189191649	.6189191649	1.163971128
	(.80873910)	(.78335149)	(1.1156224)
SKILL	-.7819159861E-01	-.7819159861E-01	-.2540501635
	(.40194442)	(.38932674)	(.55798459)
INFO	.5046299665	.5046299665	.7262020941
	(.49144092)	(.47601381)	(.67400583)
CORAL	.3648637893	.3648637893	.7371331859
	(.52703905)	(.51049446)	(.72808537)
Mean	6.35955056	6.56929675	5.39120892

The mean WTP on top of the existing entrance fee to support coral reefs conservation is above US$6 per person.

elicitation format

- **Open-ended**

  What is the maximum you would be willing to pay on top of the existing entrance fee for your recreation experience with this programme and with healthier reef?

  I would be willing to pay $_____

- **Payment Card**

  What is the maximum you would be willing to pay on top of the existing entrance fee for your recreation experience with this programme and with healthier reef?

  $0 $5 $10 $15 $20 Other (specify) ……

- **Dichotomous Choice**

  Would you be willing to pay $5 more than the existing entrance fee for your recreation experience with this programme and with healthier reef?

  □ Yes □ No

4) Choice Experiments

attributes and levels used in the choice experiments

Attribute	Short Name	Levels
Increase in Reef Quality	REEF	No change; 15%; 30%; 45%
Congestion Level	PEOPLE	usual number; 25% fewer people; 50% fewer people; 75% fewer people
Number of Dive Sites	D_SITES	15; 20; 25; 30
Increase in Entrance Fees	FEES	$5; $10; $15; $20[a]

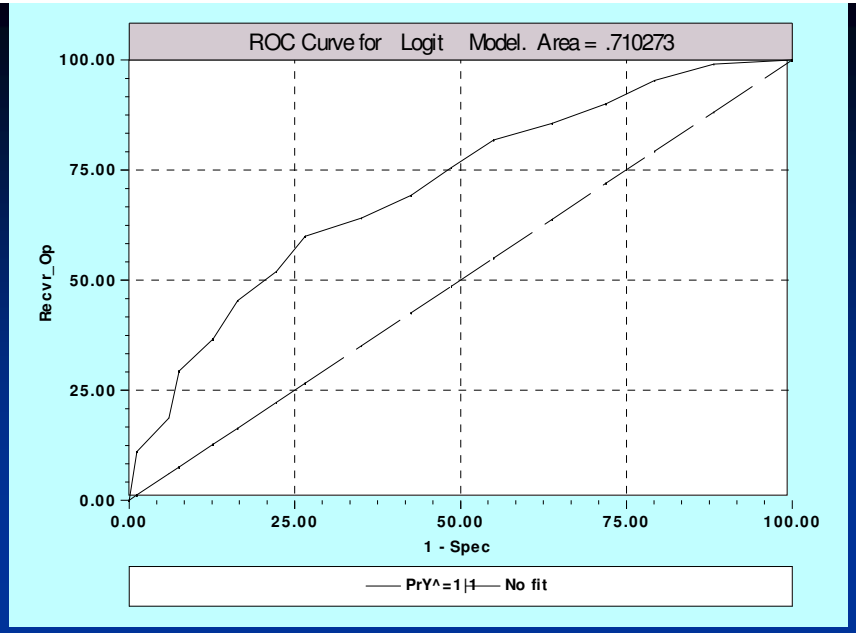
Respondents were asked to compare an alternative option against the current situation.

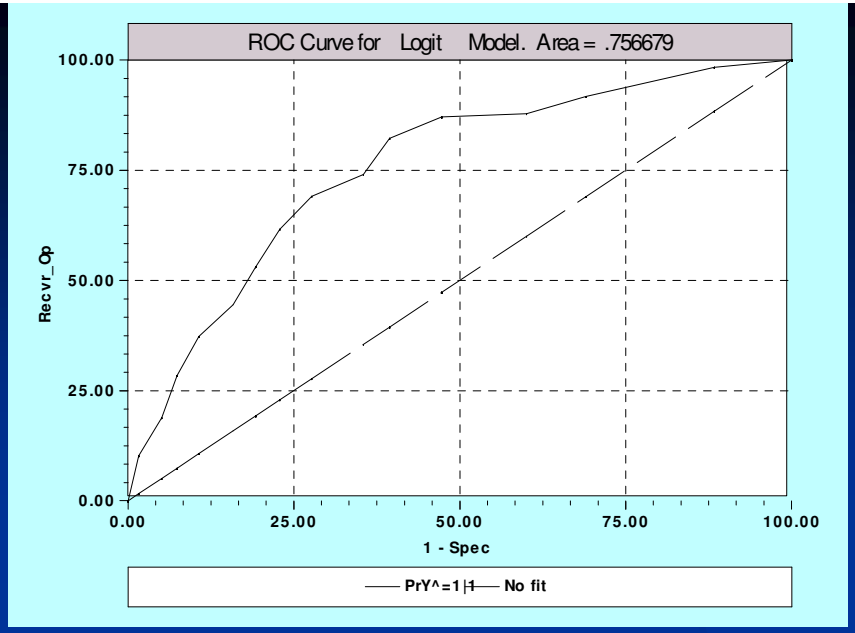
	Current Situation	Option A
Increase in Reef Quality	no change	15%
Number of People	usual number	25% fewer people
Number of Dive Sites	15	20
Increase in Entrance Fees	-	$5
I would choose		

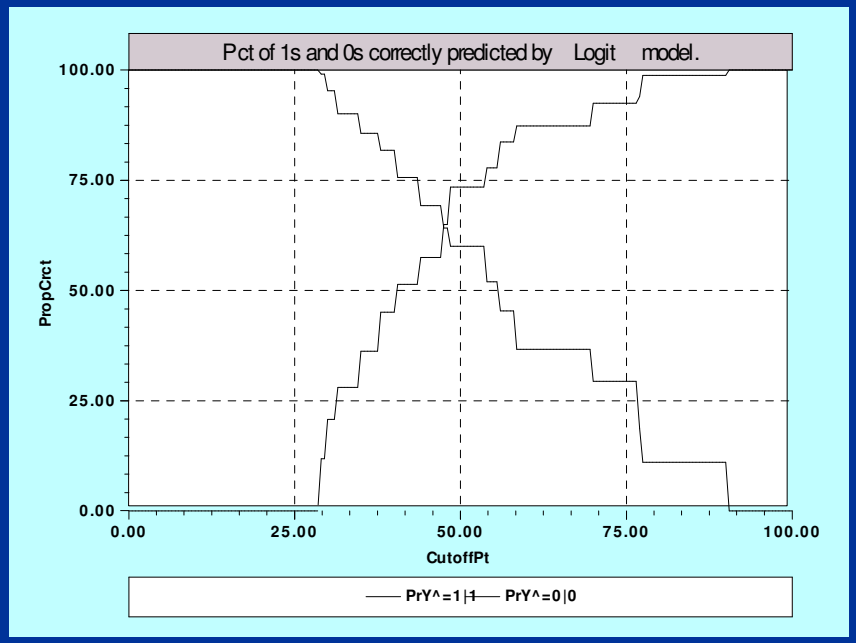
A representative choice set

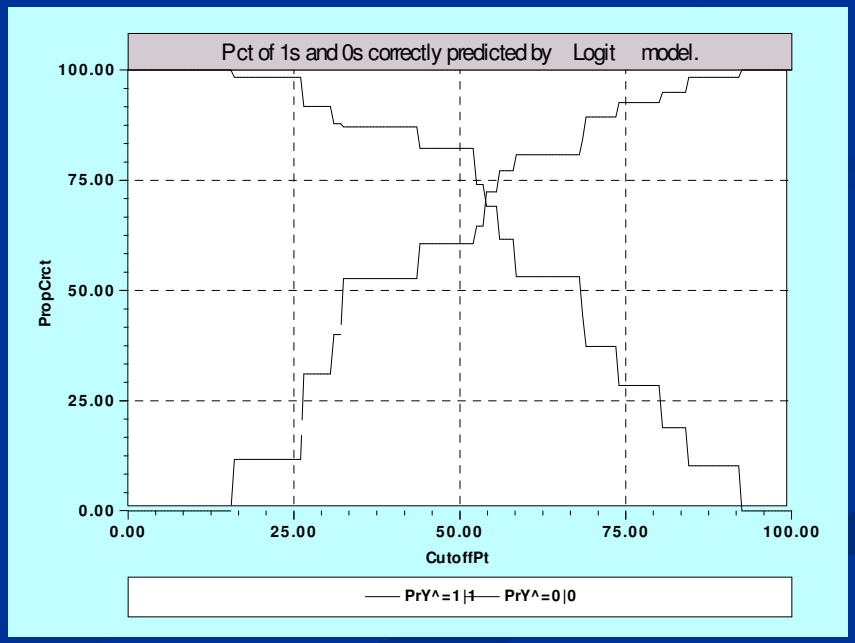
Binary Logit Models

Variable	International Tourists		National Tourists	
	Coefficient	P-value	Coefficient	P-value
CONSTANT	-0.993662	0.0000	-0.704863	0.0018
REEF	0.036770	0.0000	0.056975	0.0000
PEOPLE	0.013509	0.0000	0.003217	0.0540
D_SITES	0.031006	0.0001	0.027455	0.0010
FEES	-0.074814	0.0000	-0.088171	0.0000
Log Likelihood	-1492.605		-1392.649	
Chi-squared	339.9700	0.0000	527.0673	0.0000
Hosmer-Lemeshow chi-squared [b]	46.48249	0.0000	48.22675	0.0000
Correct prediction	66.50%		72.25%	
Observations	2400		2400	









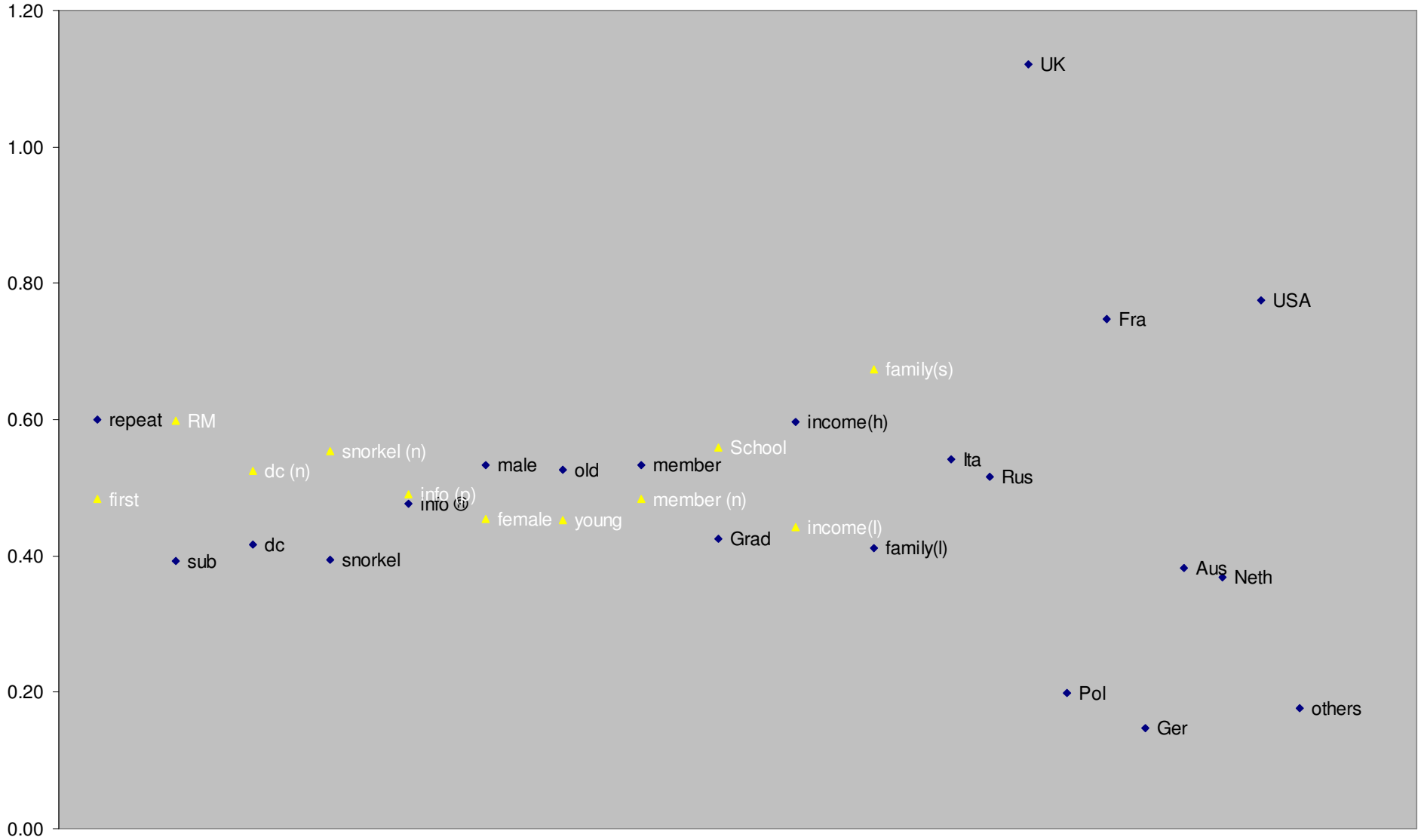
IT **NT**

ROC curve and cross tabulation of predicted values versus observed values

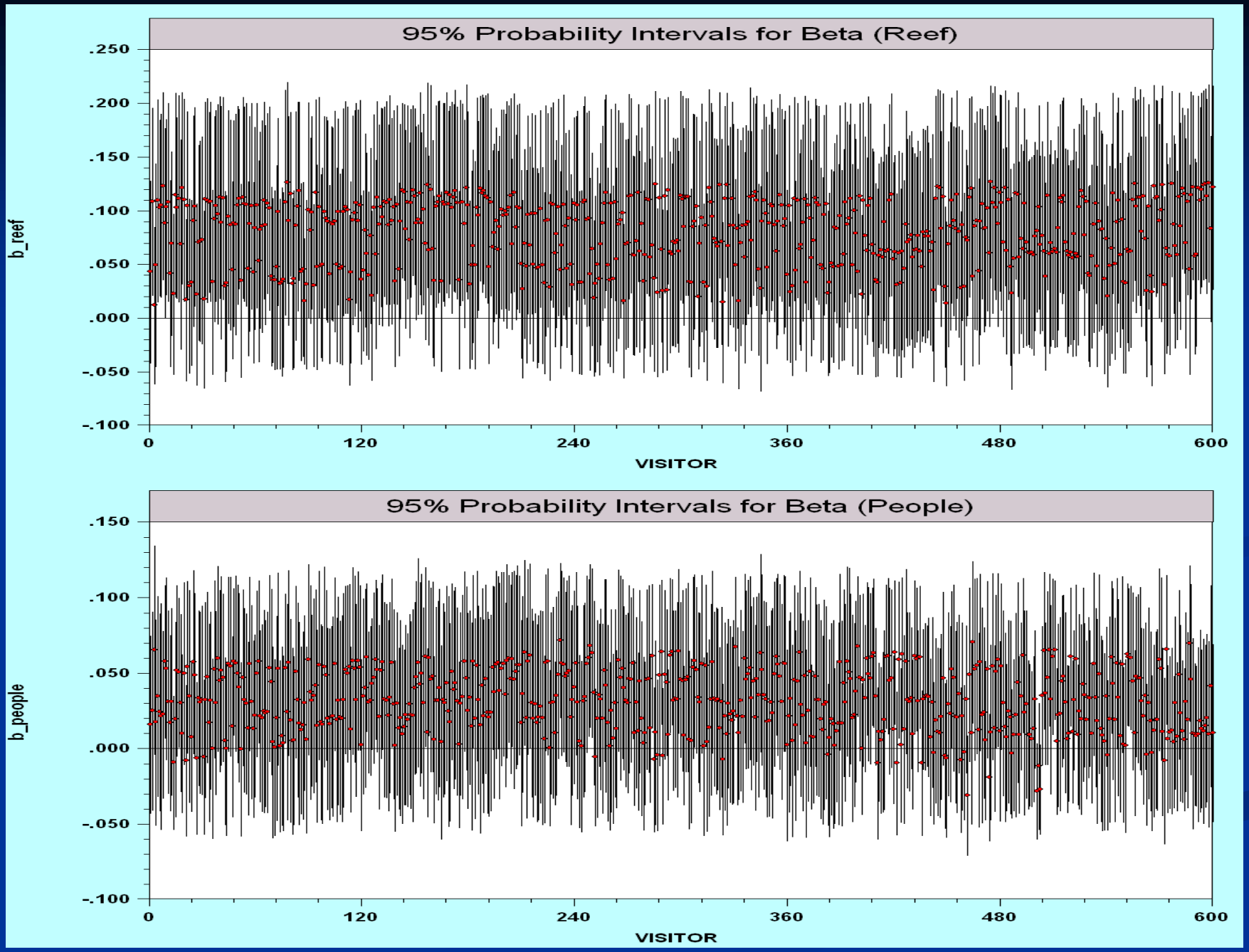
Policy Scenarios Valuation

	Reef Quality	People	Dive Sites	Fees	Probability		WTP			
							Linear		Non-linear	
					IT	NT	IT	NT	IT	NT
1	no change	25% fewer people	25	+$10	37%	34%	4.88	-1.30	6.66	-3.08
2	15%	50% fewer people	15	+$20	43%	37%	2.62	-3.81	10.49	2.60
3	30%	25% fewer people	30	+$20	42%	43%	11.69	9.64	19.02	13.14
4	45%	25% fewer people	15	+$15	71%	76%	17.85	19.66	20.89	19.57
5	15%	25% fewer people	20	+$5	66%	73%	15.18	11.83	28.20	22.38
6	no change	50% fewer people	30	+$15	31%	21%	6.46	-3.83	4.76	-8.68
7	no change	usual number	15	+$5	8%	6%	1.22	-0.33	-5.00	-5.00
8	45%	50% fewer people	20	+$10	63%	75%	29.43	27.13	32.69	27.40
9	15%	75% fewer people	25	+$15	55%	42%	16.28	5.21	22.73	11.30
10	30%	75% fewer people	15	+$10	60%	75%	24.50	16.79	26.04	17.88
11	30%	50% fewer people	25	+$5	88%	83%	29.13	23.99	35.02	26.79
12	45%	usual number	25	+$20	34%	62%	12.48	16.86	10.44	15.26
13	15%	usual number	30	+$10	53%	71%	9.81	9.03	14.05	14.64
14	no change	75% fewer people	20	+$20	31%	14%	1.83	-11.04	-0.51	-14.16
15	30%	usual number	20	+$15	51%	65%	8.03	10.61	11.07	14.65
16	45%	75% fewer people	30	+$5	91%	88%	43.09	36.16	41.22	32.67
		Average			51%	54%				

The Results Conditioned on Individual Characteristics



WTP for higher reef quality conditioned on individual variables (IT model)



Confidence intervals for conditional means in IT model

- The highest WTP value ($0.5 for IT and LE0.7 for NT for each 1%) was found for an improved reef quality (the greatest contributor to welfare).

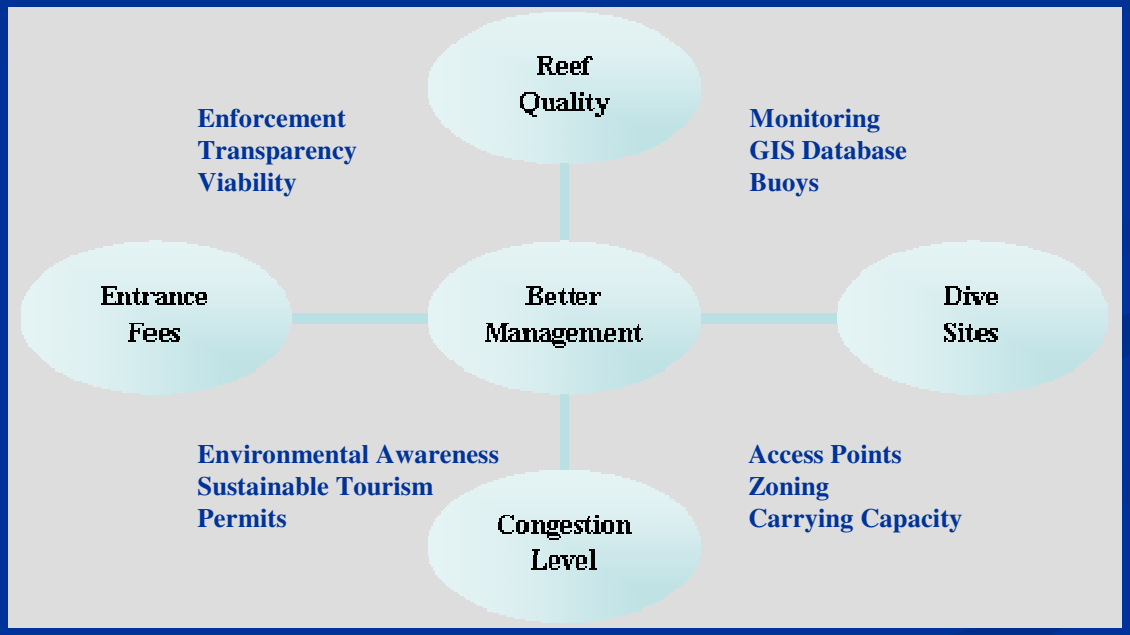
- The corresponding figure for less people at reef site was $0.2 (LE0.05 for NT) and $0.4 (LE0.3 for NT) for more dive sites.

- Based on the total number of visitors to Ras Mohammed of 495,382 in the year 2008/09, the annual WTP on top of the existing entrance fees was estimated to be $238,656 for each 1% increase in the reef quality, $94,994 for each 1% decrease in the congestion level and $189,779 for each additional dive site.

WTP values derived from BNL and RPL models

	BNL	Unconditional Parameters	Unconditional (truncated) distributions	Conditional (unconstrained) distributions	Conditional (constrained) distributions
International Tourists					
Reef Quality					
Mean	**0.49**	**0.0038**	**0.2399**	**0.49597**	**0.3884**
Std. Dev.		14.5112	1.4936	0.40973	0.1591
Minimum		-353.4960	-6.1625	-0.0884	0.1643
Maximum		195.4700	7.6008	1.85042	0.7632
Uncrowding Conditions					
Mean	**0.18**	**-0.0392**	**0.0804**	**0.20527**	**0.1586**
Std. Dev.		7.3565	0.7572	0.20878	0.0605
Minimum		-179.2470	-3.1653	-0.2416	0.0755
Maximum		99.0530	3.8121	0.87082	0.3128
No of Dive Sites					
Mean	**0.41**	**0.0833**	**0.2204**	**0.36624**	**0.5472**
Std. Dev.		8.4278	0.8674	0.28577	0.2501
Minimum		-205.2220	-3.4980	-3.3815	0.2294
Maximum		113.6060	4.4955	1.41715	1.1959
National Tourists					
Reef Quality					
Mean	**0.65**	**-0.1959**	**0.5667**	**0.79351**	**0.63657**
Std. Dev.		28.6163	2.5174	0.58493	0.26538
Minimum		-766.9810	-10.4251	-0.0228	0.2046
Maximum		348.4510	11.4188	2.7263	1.31606
Uncrowding Conditions					
Mean	**0.04**	**0.0023**	**0.0444**	**0.05591**	**0.04324**
Std. Dev.		1.5784	0.1389	0.02676	0.01202
Minimum		-42.2908	-0.5619	0.03352	0.02876
Maximum		19.2324	0.6430	0.16951	0.0804
No of Dive Sites					
Mean	**0.31**	**-0.0008**	**0.2373**	**0.30527**	**0.40663**
Std. Dev.		8.9319	0.7858	0.16276	0.15391
Minimum		-239.3360	-3.1936	0.1643	0.20353
Maximum		108.8210	3.6245	0.98148	0.86813

- The evaluation of visitor preferences with regard to the park attributes is an important tool for developing strategies to adapt especially where economic and conservation objectives overlap and could provide useful information for the policy makers concerning decisions of improving reef quality, regulating some activities inside the park, and the allocation of resources for each attribute.



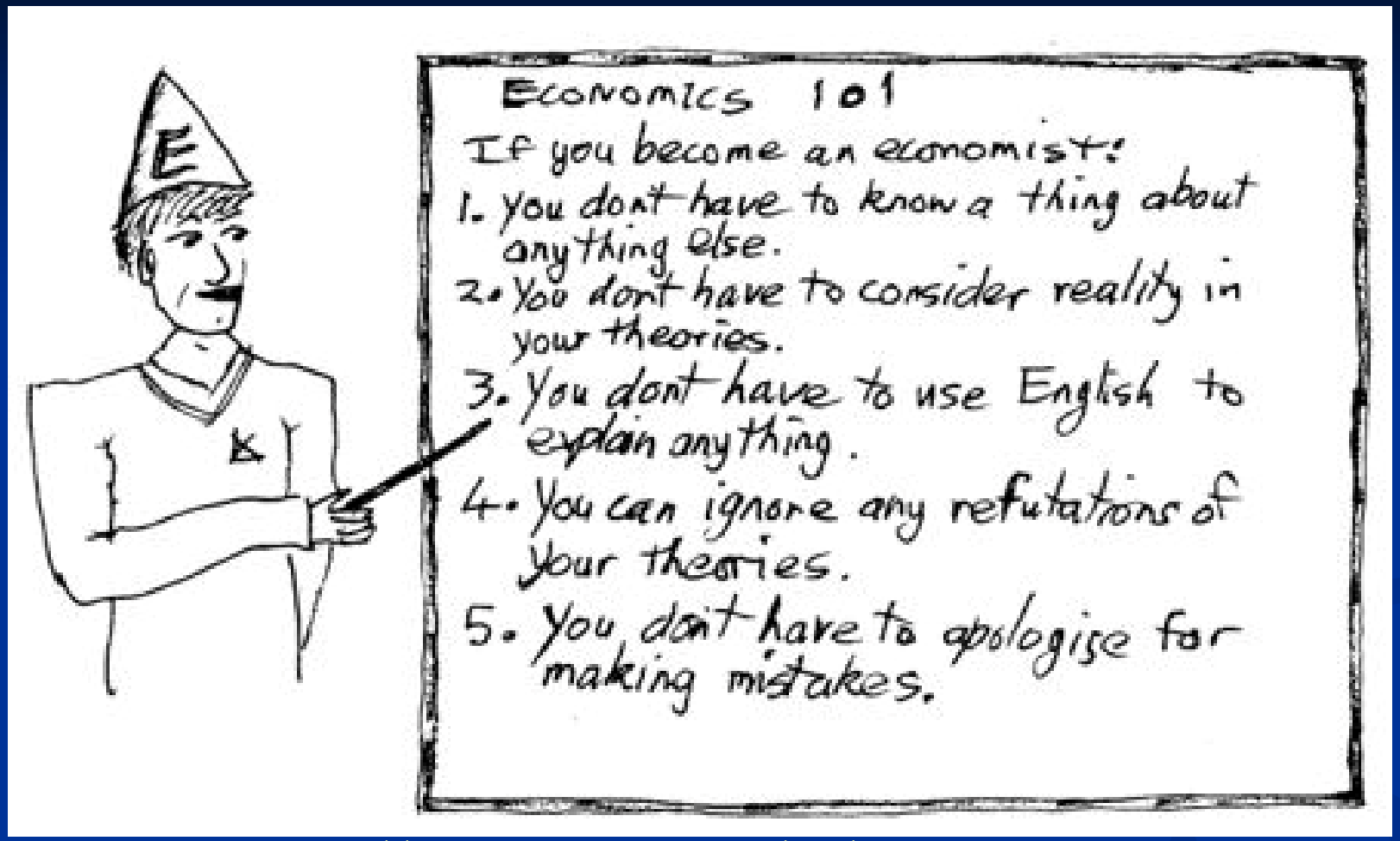
Choice experiments attributes and management strategies

How to Start

identification comes first then valuations are carried out where possible.

1) **select the appropriate assessment approach** (impact/damage analysis, partial valuation, total valuation)
2) **define the spatial system boundary of the ecosystem**
3) **identify the services of the ecosystem and potential benefits provided by them**
4) **assess their actual provision level (including quality)**
5) **identify the groups of people in society who benefit from them**
6) **select the appropriate economic valuation technique**

Lauretta Burke, World Resources Institute (WRI), Tobago, 2006



http://kvams.wordpress.com/tag/john-whitehead

Thank you