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Summary

This paper updates the existing meta-analysis in coral reef recreation taking into account the previous work of Brander et al. (2007) but considering some stated preference biases and/or effects. The present meta-analysis uses twice the number of observations as the previous one and sheds more light in understanding the influence of these common biases and/or effects found in valuations. The results show the common biases/effects in varied methodology types significantly influence the willingness to pay (WTP) estimates and in turn this has implications in welfare and benefit transfer at local, regional and global levels.

Keywords: Meta-analysis, Coral Ecosystem, Valuation, Willingness to Pay, Biases

JEL Classification: Q54, Q57

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Controlling for biases in primary valuation studies: a meta-analysis of international coral reef values

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This paper updates the existing meta-analysis in coral reef recreation taking into account the previous work of Brander et al. (2007) but considering some stated preference biases and/or effects. The present meta-analysis uses twice the number of observations as the previous one and sheds more light in understanding the influence of these common bias and/or effects found in valuations. The results show the common biases/effects in varied methodology types significantly influence the willingness to pay (WTP) estimates and in turn this has implications in welfare and benefit transfer at local, regional and global levels.

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1. Introduction

The living coral ecosystems provide a wide range of goods and services to the ocean life as well as to human development. However, such delicate biomes are on the verge of being destroyed, both by natural and anthropogenic events. Several of these essential services include regulating, provisioning, cultural and supporting services. One of the great attempts made by environmental economists is placing a total economic value using market and non-market methods to services using valuation methods.

The case of coral is of recent interest as pointed out by the Intergovernmental Panel on Climate Change (1995) that they would be among the first to be stressed by climate change. Moreover, apart from climate change as a natural threat the other major threats stems from anthropogenic activities. Consequently, the current interest in coral reef valuation studies is examining not only the non-use and use values but also the management/protection efforts for coral reef sites, offering one of the various possibilities in understanding the welfare benefits and/or loss from human-induced activities.

In recent years the attention given by researchers, government organizations and non-profit organizations in valuing coral reef services in economic terms has increased. Valuation studies using hypothetical scenarios as in stated preference methods (such as contingent valuation and choice experiment) as well as behavioural (i.e. hedonic and travel cost method) have been studied. In most of these studies the cultural services contribute a higher proportion of studies than regulation, provision and supporting services. Specifically, the cultural services consist of the non-extractive nature of recreation services in the form of tourism.

The objective of this paper is to enrich the previous meta-analysis work done by Brander et al.. (2007) by consolidating and examining more recent coral reef studies in two ways: to test the National Oceanic and Atmospheric Administration (NOAA) (Arrow et al., 1993) recommendations pertaining to contingent valuation method (CVM) and focus on constraints related to primary valuations studies when transferring these values to other sites particularly the developing countries, where most the coral reef resources are abundant and under natural and anthropogenic threats. As far as we are concerned this is the first study to consolidate the previous work by including other variables which are aligned to the Blue ribbon NOAA guidelines specifically related to biases and/or effects. As a matter of fact, biases and/or effects can be created on two levels: from valuation

designers and respondents.[1] It would be reasonable to argue that mitigation efforts to ameliorate these biases and/or effects should include all parties, namely both researchers and respondents, when designing and responding to the questionnaire, respectively. However, if the framework for valuation studies takes into account the views of these protagonists, particularly the valuation design, then there is a greater possibility of the research results being accurate. Hence, the greatest burden falls on valuation designers and importantly, reducing some of these common biases[2] have policy implications. A case in point is the anchoring effect and if uncontrolled can lead to an overstated WTP, which can result in plausible erroneous policy decisions (Herriges and Shogren, 1996). Nevertheless, the paper provides more explanatory variables in the form of quantitative and categorical related to biases and/or effects on WTP estimates.

Meta-analysis estimation is not novel and, in fact, previous environmental studies have applied this approach in areas such as ground water (Boyle et al., 2001), cultural (Noonan, 2003), wetland (Woodward and Wui, 2001), outdoor recreation (Rosenberger and Loomis, 2000) and endangered species (Loomis and White, 1996). The advantage of meta-analysis as illustrated by these recreational estimates is that they provide a value aggregated from all primary valuation studies and such that the estimated value is helpful in transferring to other sites (i.e. benefit transfer). It is important for the meta-analysis that sufficient and reliable sources are located such as from relevant journals, articles and conference programs and proceedings.

This paper is structured in the following sections. Section 2, provides the previous meta-analysis in coral reefs and comparison to the current one. Section 3, introduces the database and data description of the variables of interest and section 4 reports the empirical results. Subsequently, the discussion of the results and conclusion are given in Section 5.

2. Background to coral recreation meta-analysis

As mentioned earlier, the first meta-analysis on general recreation involving coral reefs was published in a peer-reviewed journal by Brander et al. (2007) where they considered about 52 studies with 73 observations. In the methodology part of their study they had covered both stated

[1] In other cases we attempted to identify some more biases and/or effects as outlined in Mitchell and Carson handbook (1989) for the case of the CV method however due to the limited data availability from the primary studies there were insufficient variables to run some biases/effects ranging from sample design to sponsorship bias.
[2] Some of common biases include: starting point bias, yea-saying, hypothetical bias, as well as the question order and temporal embedding effects. Others are population choice bias, sampling frame bias, social desirability bias and protests (see Mitchell and Carson 1989, Bateman et al. 2002 for more details)

preference methods as well as travel cost methods and production functions, gross revenue, etc. Ever since their study was published in 2007, numerous primary studies have emerged in coral reef, mostly in emerging and developing countries where choice experiment (CE) has been favoured. Apart from Brander et al. (2007) other recent attempt by Diaz-Londono and Johnston (2010) covered over 30 reef studies with around 71 observations for only contingent valuation method (CVM).

Table 1 depicts the comparison of methodology, study and context attributes between the first previous study and the current one on valuation of coral reef ecosystem. It can be seen that the current work explores more methodological (study) characteristics than other attributes and has more methodological variables compared to the previous one.

Table 1: Previous meta-analysis studies compared to current one on coral recreation

Status	Previous	Current
Author	Brander et al (2007)	Abdullah & Rosenberger (2012)
Year range	1991-2004	1993-2010
Methodology(study) characteristics	Contingent valuation, travel cost, production function, net factor income	Choice experiment (CE), contingent valuation method (CVM), travel cost method (TCM), others (revealed and other methods), stated preference elicitation format, picture, questionnaire translation, sample size, cheap script, publication type, survey year
Site (good) characteristics	Dive site area, number of visitors, East Africa, snorkelling	Payment vehicle, reef and marine protected area (MPA) ratio, on-site survey, user type (non-local)
Context (activity) characteristics	Gross revenue	GDP per capita, signatory to the convention of biodiversity (CBD)
Number of studies	33	53
Number of observation*	73	144-164
Average study per observation	2.21	2.71-3.09

Notes: * variables in final regression estimation

Significantly, this work supersedes the previous works in two distinct ways: firstly, we have added more recent stated preference studies for both natural and artificial reefs and secondly, we evaluate some biases and/or effects found in methodology characteristics.

Critics have argued the methodology type such the CVM has greater number of biases when compared to other valuation methods, such as CE, hedonic and travel cost method (TCM). Also, common biases like hypothetical bias, interviewer bias (Carson et al. 2001, Kahneman and Knetsch 1992); information and payment vehicle bias (Cummings et al. 1986), certainty of responses, budget constraint or cheap talk script etc (Bateman et al., 2002 and Mitchell and Carson, 1989) are known to influence WTP estimates. In this vein, we identify some methodology effects/biases such as: elicitation format, sample size, cheap talk script, payment vehicle, picture presentation and questionnaire translation. Some various meta-analysis studies that have evaluated these biases and/or effects in primary valuations include scoping effects (Smith and Osborne 1996, Ojea and Loureiro 2011) to hypothetical biases (Murphy et al., 2005). Nevertheless, this study extends the previous works by identifying more forms of biases and/effects thereby examining how these affect benefit transfer values in other varied sites.

3. Database and data characteristics

Most of studies covered in the current database were retrieved from both published and unpublished and were obtained from several databases such as: Econlit, International Bibliography of Social Sciences and Web of Knowledge, Environmental Valuation Reference Inventory (EVRI), Environmental Valuation, and Cost-Benefit News (EVCBN), ReefBase, Nature Valuation and Financing Network Case Study Database and Google Scholar website. Moreover, grey literature such as conference proceedings and unpublished academic papers and vendor reports were added to the meta-database to reduce publication bias. [3] Similar to other meta-analysis, the searching of the publication were restricted to English language leaving out foreign literature available in Spanish or French. Moreover, this database varies from the previous one (see Table 1) because the number of explanatory variables assessed in this work is extensive and relevant to biases and/or effects on WTP estimates. For instance, the data year between 1993 and 2010 resulted to a total of around 170 observations with more than twice the number of observations in final estimation compared to Brander et al. (2007).

[3] Publication bias occurs when researchers selectively choose published articles which are selected by journal editors who deem significant results as publishable materials. Consequently, this excludes other studies that may be considered important

Database characteristics- the variables

The dependent variable in the analysis is the WTP converted to annual mean per person (US$ 2005) adjusted for inflation rates by using the implied Purchasing Power Parity (PPP) rate found on the International Monetary Fund (IMF) World Economic Outlook 2006. All explanatory variables used in methodology characteristics were obtained from the meta-analysis database except for the site and context characteristics where the GDP per capita was obtained from World Bank (2010) HDI database, reef areas and marine protected areas from World Databases on protected area (2009) and signatory to Convention on Biodiversity Diversity (CBD) as seen on their website (2011).

In the appendix we summarize the selected studies from the meta-database by author, year methodology and region (see Table 1A). Most of these studies involve recreational studies elicited from tourist both local and non-local with the most commonly used stated approach is CVM with around 70% of the total studies followed by CE (20%), TCM and others (revealed and mixed type). Table 2 shows the number of studies conducted between the years 1993-1998, 1999-2004, 2005-2010 by varied regions. Evidently the number of CE has increased especially among small islands and emerging economies. The dominance of CVM as a stated preference approach in valuing reef services is a case in point in examining common biases and/or effects inherent among this methodology type.

Table 2: Selected number of stated preference observations by group (year) and regions

Year/Region	**Stated preference type**	
1993-1998	CE	CVM
Caribbean & small island	0	1
N. america, US	0	1
1999-2004		
Africa, east	0	2
Caribbean & small island	4	11
Europe, south	5	1
N. america, US	0	44
Oceania, mela, micro & poly	0	6
South east asia	0	11
2005-2010		
Africa, east	0	3
Australia	6	0
Caribbean & small island	3	4
Central America	0	2

Europe, south	8	3
N. america, US	1	3
Oceania, mela, micro & poly	3	7
South asia	0	2
South east asia	0	12

Shown in Table 3 are the main variables of interest used at the final estimations.[4] Taking into account the valuation guidelines especially related to NOAA directives (Arrow et al. 1993) we select a number of common biases and/or effects in the meta-analysis such as: payment vehicle type, cheap talk script, sample size, elicitation format, on-site survey, picture and questionnaire translation.

Table 3: Variables of interest and descriptive statistics

Variable	**Description**	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
lwtpersyr	log of WTP per person/year (continuous)	164	1.554	3.111	-7.461	13.230
TCM	valuation type travel cost method (dummy)	170	0.118	0.323	0	1
CVM	valuation type contingent valuation method (dummy)	170	0.665	0.473	0	1
CE	valuation type choice experiment (dummy)	170	0.176	0.382	0	1
OTH*	valuation type others (dummy)	170	0.012	0.108	0	1
sp_elictfo~e	stated preference format=close ended questions	170	0.400	0.491	0	1
sp_elictfo~b*	stated preference format=combination	170	0.047	0.212	0	1
sp_elictfo~n	stated preference format=open ended questions	170	0.094	0.293	0	1
sp_elictfo~y	stated preference format=payment card	170	0.159	0.367	0	1
samplesize~e	sample size usable	169	375.485	526.577	0	4064
cheapdum	variable cheap talk script yes (dummy)	170	0.518	0.501	0	1
picdum	variable picture/pictorial yes (dummy)	170	0.265	0.442	0	1
entrfee	entrance fee as payment vehicle (dummy)	170	0.341	0.476	0	1
qustradum	whether questionnaire translation (dummy)	170	0.182	0.387	0	1
pubdum	publication book or peer reviewed only (dummy)	170	0.365	0.483	0	1
datayrindex	year the study was conducted converted to index by subtracting 1991	170	10.918	3.848	0	18
sitesurdum	variable survey on-site (dummy)	170	0.376	0.486	0	1
user_nonre~r	user type international tourist	170	0.200	0.401	0	1
reef_mpara~o	ratio of reef area to MPA(sq. km)	170	4.423	19.682	0.004	165.185
gdpcurtho	GDP per capita, PPP (constant 2005 international $) divided by 1,000	170	20.115	17.054	0.348	56.459
CBDfirsyr	signatory to first years of CBD 1992/1993	170	0.659	0.476	0	1

Note: missing values may not be accounted in final estimations

* omitted variable in final estimation

[4] Some of the biases and/or effects found in the database including: pre-test or pilot, protest size, split-samples, gender type, follow up and certainty levels were insignificant and not included in the final estimation.

We acknowledge the fact that the payment vehicle such as tax, price increase in a bill and fee for the good or service affects the WTP estimates (Hanley and Spash, 1993). However, in this study we specifically take the entrance fee for users as a payment vehicle apart from other forms such as tax, trip cost, donation, because most recreational services in tourism activities impose an entrance fee than other payment forms. In this vein, we take into account the effect of on-site survey as a pertinent variable in recreational valuation as respondents are in presence of the goods and/or services being evaluated.

With regards to elicitation format type; this is an important feature in estimating WTP in CV studies, such formats include: open-ended, closed-ended, dichotomous choice, bidding game and take-it-or-leave-it questions (Mitchell and Carson, 1989). These techniques are known to yield possible differences in WTP values (Carson et al., 2001). The respondents find open-ended questions more strenuous to answer than closed-ended questions, because the former give them 'cognitive burden' or are considered a tiresome activity (Hanemann, 1994). In this study we managed to find open-ended, closed-ended, combination and payment card.

Similarly the sample size depends on survey budget thereby varying with methodology type. Freeman (1986) points out that the high cost for CVM is a function of accuracy which heavily depends on the sample size and effort to reduce bias and errors. Others have confirmed in their study (Arkesteijn and Oerelemans 2005, Han et al. 2008) the limited funding coupled with high cost of stated preference studies limit sample size and time to collect responses.
Nevertheless, the NOAA directive in pre-testing photographs, maps, etc. is the belief that visual aids are known to influence the WTP. Mitchell and Carson (1989) stated that using pictures to present actual scenario runs the risk of 'reality-enhancement' and respondents may provide WTP estimates based on their subjective views of pictures. Finally, we hypothesize questionnaire translation is relevant in influencing the WTP values especially when describing hypothetical scenarios though as pointed out by Bulmer and Warwick (1993) there are other challenges[5] encountered when translating the surveys into local languages however these issues are not covered in this study.

Moreover, one way to reduce a hypothetical bias is the use of 'cheap talk' script in the questionnaire

[5] Such problems include lexical equivalence (equivalence in the same words), conceptual equivalence (equivalence in meaning), equivalence in measurement (equivalence measuring from one site or culture to another) and equivalence of response in a cross-cultural survey

design (List et al. 2006). Cheap talk is the use of script statements that caution respondents on biases, prior to providing their WTP values for a good (or service). In this context, we explore the use of cheap talk, however, due to limited information available we did not unravel the length and content of these statements.

4. Empirical model and discussion of results

For the meta-analysis regression (MAR) the semi-log form is used (see equation 1 for ordinary least square (OLS)) where the log WTP per person/year (dependent) is regressed against three independent components: methodological (or study) characteristics such as valuation type, elicitation format, year, cheap talk script, sample size, publication type, vehicle payment; site (or good) including reef to MPA ratio, on-site survey, user type; and context (or activity) associated with GDP per capita as a proxy for income and CBD year.

$$Y_1 = \alpha + \beta' x_1 + {}_+ \varepsilon_1 \qquad (1)$$

where y is the log of WTP per person/year adjusted to 2005 US$ and α and β are the intercept and slope coefficients. x_1 consists of explanatory variables including methodology (1), site (2), and context (3) characteristics, and ε_1 is the error term with mean zero and variance $\sigma^2_{\varepsilon.}$ Regarding the OLS regression this is subjected to heteroscedasticity and autocorrelation hence we used robust standard errors. Moreover, taking the recommendation of Rosenberger and Loomis (2000) we verified the panel stracture of meta-analysis by estimating another, random effects model (REM), taking into accounta panel effects structure where there is specific disturbance component μ_{1j} and the error component ε_1 as shown in equation (2).

$$Y_{1j} = \alpha + \beta' x_{1j+} \varepsilon_{1+} \mu_{1j} \qquad (2)$$

This is also confirmed by Nelson and Kennedy (2009) suggestion that REM takes into account all primary studies selected randomly from a distribution. In sum, we carried out four models (as shown in Table 4 for both OLS and REM groups in all valuation and contingent valuation methods. In the case of OLS, we clustered by study implying that there is lack of independence for WTP estimates within a study in other words the WTP estimates from one study is likely to be similar to one another than those between studies. Additionally, we carried out a Breusch and Pagan Lagrange-multiplier test to test whether random effects is favoured against the OLS for all and CV studies. In sum, we rejected the null hypothesis that there are no random effects in other words the

REM is the appropriate model instead of the pooled OLS for CVM. Nevertheless, the variance inflation factor (VIF) test affirms that there is no multicollinearity; in other words the variables are uncorrelated as the VIF are all below 5.

Table 4: Meta-analysis regression results ordinary least squares (OLS) and random effects model (REM)

(standard errors in parenthesis)

Variable	**OLS all**	**OLS CVM**	**REM all**	**REM CVM**
TCM	3.4996885***		3.4019508***	
	(1.086173)		(0.8513999)	
CVM	0.41390534		0.09469166	
	(0.6264974)		(0.511252)	
CE	-0.29153308		-2.2008208**	
	(0.9284964)		(0.8647692)	
sp_elictfo~e	-0.29875525	-0.90646181	-0.63365306	-0.6531852
	(0.6114703)	(0.9552696)	(0.588607)	(0.6403117)
sp_elictfo~n	-1.0538632	-0.98645051	-4.3407504**	-0.6354373
	(0.8359755)	(1.106908)	(1.897896)	(1.017282)
sp_elictfo~y	0.03700248	0.09695481	0.09032989	-0.525232
	(0.6964503)	(0.8617367)	(0.7182107)	(0.5181316)
samplesize~e	0.00025979	.00045825***	.00045811***	.000453***
	(0.0002274)	(0.0001146)	(0.0001017)	(0.0000866)
cheapdum	-0.9959642	-0.74806747	0.63844699	0.2260632
	(0.6837071)	(0.8660117)	(0.6369732)	(0.5664745)
picdum	0.39530852	0.72951679	-0.86729072	-0.4365498
	(0.5320306)	(0.9439117)	(0.7386348)	(1.535797)
entrfee	-1.5870813*	-1.1344192	-0.37051147	0.6138458
	(0.8544903)	(0.8821249)	(0.5819688)	(0.4081557)
qustradum	-0.09224122	-0.05714414	-0.22764843	-0.2206009
	(0.9330296)	(0.825312)	(0.6791639)	(0.3766238)
pubdum	1.5180732***	1.3772836*	0.33796541	1.2961157*
	(0.5104771)	(0.7274115)	(0.7444772)	(0.7436592)
datayrindex	-0.04364823	0.07471152	0.06399013	-0.0148925
	(0.0603731)	(0.1283587)	(0.0598929)	(0.1074871)
sitesurdum	-0.62709803	-0.67411876	0.10672227	0.4918103
	(0.4711816)	(0.8280884)	(0.4040111)	(0.4140186)
user_nonre~r	1.1397176**	0.55566956	.99054892**	.54472237***
	(0.5409962)	(0.3848727)	(0.4159694)	(0.1930313)
reef_mpara~o	.02108935**	.01645057*	.03586104***	0.0222196
	(0.0089884)	(0.0087877)	(0.0109035)	(0.0152982)
gdpcurtho	.11295747***	.11300772***	.13005229***	.14350732***
	(0.0161115)	(0.0184329)	(0.0207807)	(0.0215282)
CBDfirsyr	-0.3710262	0.06649826	-0.11524554	1.5452799*
	(0.8922548)	(0.8965186)	(1.018453)	(0.8625928)
_cons	-0.17469444	-1.2193491	-1.1465715	-2.6298095*
	(1.467836)	(1.519922)	(1.524135)	(1.458875)
ll(null)	-416.0136	-246.7259		
ll(model)	-320.4824	-185.7173		

Df	19	16	No. of groups	51	33
AIC	678.9648	403.4346	within errors r2	0.5906	0.5171
BIC	737.746	446.4962	between errors r2	0.5064	0.5257
R^2(OLS)	0.6903	0.6735	overall r2	0.4572	0.5519
VIF	3.77	3.3	P-values	0.000	0.000
N	163	109	N	163	109

Significance indicated as follow: * p<0.1; ** p<0.05; *** p<0.01

For the case of REM, the coefficients signs are similar to the OLS except in some cases the significance levels. Interpreting the significance for methodology variables indicates that the valuation type has a positive effect on WTP, particularly the revealed form (i.e. TCM in contrast to CE). Similar findings in previous meta-analysis such as Brander et al. (2007), Johnston et al. (2006), Diaz-Londono and Johnston (2010) show that TCM is positive and significant conversely to some stated preference approaches. Additionally, the various elicitation format negatively influences the WTP modes this is particularly significant for REM model for the open-ended questions (*sp_elictfo~n*).

Regarding the sample size, this has a positive effect on WTP and can be explained by the fact that more respondents there are, the greater the WTP values are. However, this finding should factor the availability of funds and/or time may determine the survey size and is beyond the valuation design.
For the other biases/effects such as cheap talk script, picture/pictorials as well as questionnaire translation, *Datayrindex* and on-site survey; these variables depicted mixed signs between the two models and were insignificant for all valuation and CV methods.

One of the commonly cited socio-economic variables in the context component of meta-analysis is the GDP per capita which is a proxy to income. In our case like other meta-analysis studies, the variable is positive and highly significant meaning the higher the income of the respondent, the more they are willing to pay more for the recreational service or goods. Additionally, for non-local users their WTP is positive, meaning those who are out of the area are willing to pay more for recreational activities than their local counterparts. Lastly, publication in peer-reviewed and/or book and reef area to MPA area ratio positively influences the WTP. The former means that that peer-reviewed and/or book chapter tend to report higher WTP values than other sources such as conference proceedings, government and academic reports. For the latter variable, the ratio is relevant in policy implementation of managing and conserving the ecosystem where it insinuates that if the area has greater reef coverage than MPA then respondents are willing to pay higher for these goods or services. Finally, for countries and/or states that were the first signatories in

1992/1993 to the CBD, these have high WTP estimates this is evident for the case of CVM found in REM only. A plausible explanation is that CV approach considers the total economic value for programmes and this implicitly means that the estimates takes into account the indirect effects of governance and/or institutions in place, that is to say if favourable they influence the WTP positively.

All in all, the interpretation of these effects and/or biases should be treated with caution, particularly when WTP values are distinguished by different methodology characteristics. Indeed, biases/effects connected to valuation methods are within the control of valuation designers than those held by respondents. Hence, it is imperative for valuation designers to recognize these biases and/or effects and to explore a level playing field to mitigate them in order to achieve survey efficiency. This can be achievable as long as values associated with welfare, as well as benefit transfer, can account for the common biases rooted in the methodology characteristics.

In this vein, we apply benefit transfer by forecasting from the meta analysis function (the 35 coral endowed countries and territories illustrated in Table 4) to additional of 68 countries and territories (policy sites) for only the CVM. In this case we divided these countries and territories into four economies categories as suggested by the World Bank income classification: low, low middle, upper middle and high. As shown in Table 5, the forecasted values estimated according to Rosenberger and Loomis (2001) approach include all methodological variables, study site and context characteristics for coral endowed economies at the global scale. The mean values for the methodological variables such as elicitation formats and biases and/or effects found in Table 3 and their respective coefficients in Table 4 (REM column). For the base-case scenarios the values were the mean and respective coefficients for all variables; whereas for bias and no bias scenarios we turned on (1) or off (0) respectively. With regards to the context characteristics (*reef_mpa* ratio and *GDP per capita*) we inserted their respective values from the policy sites. Moreover, we avoided double-counting the initial 35 countries and territories found in the original studies when transferring the benefit transfer to the policy sites.

Table 5: Meta analysis benefit function transfer scenarios for the mean recreational values for varied economies (in US$) for CVM

a) low		*b) low middle*	
base-case	116	base-case	176
bias	246	bias	306
no bias	31	no bias	90
c) upper middle		*d) high*	
base-case	269	base-case	558
bias	400	bias	688
no bias	184	no bias	472

Notes: Low countries (Madagascar, Mozambique & Tokelau excluded *Somalia as outlier), low middle (Bangladesh, Cambodia, Cameroon, Djibouti, India, Kiribati, Marshall Islands, Nicaragua, Pakistan, Papua Guinea, Solomon Islands & Sudan), upper middle (Belize, Brazil, China, Colombia, Costa Rica, Domenica, Dominican Republic, Ecuador, Grenada, Honduras, Indonesia, Jamaica, Jordan, Mauritius, Monterrat, Palau, Panama, South Africa, Sri Lanka, St. Lucia, St. Vincent and the GrenadinesTonga, Turks and Caicos Islands, Tuvalu, Vanuatu & Venezuela) and high (Anguilla, Antigua and Barbuda, Bahrain, Brunei Darussalam, Cayman Islands, French Polynesia, Japan, Kuwait, New Caledonia, Oman, Puerto Rico, Qatar, Saudi Arabia, Singapore, St. Kitts and Nevis, Trinidad and Tobago, United Arab Emirates, Virgin Islands, British & Virgin Islands, United States).

Significantly, what is emerging from the adaptation of the meta-analysis estimation is the inclusion of biases is relatively inflated to no bias and base-case scenarios irrespective of the economy type. This is more pronounced for the poor economies where the inflated bias rate compared to base-case scenario was as high as 110% compared to rich economies at 48%. This may be explained by the lower incomes effects found in these groups who are willing to pay less than high income economies. Another explanation can be attributed to the number of CVM studies conducted in poor economies are less than the rich economies particularly related to recreational services. Despite the difficulties of carrying out the CVM in comparison to other stated preference approaches, it is been used more frequently in the context of both developed and developing countries. Though the majority of CVMs in all sectors have been applied in developed locales, such as: the USA, Canada and Europe and relatively few have focused on the developing countries. Nonetheless, in a study analyzing 73 developing countries that had 250 CV studies, it was found that the greatest number of CV studies had been conducted were in countries with high income levels and large populations (Biller et al., 2006). Significantly, the cost of valuation determines the sample size particularly for lower economies who are highly affected by financial as well as sampling issues. In sum, the overall policy implication of these estimates illustrate that these biases varies according to the economies which in turn affects the recreational benefits towards conservation and management efforts for a multi-functional ecosystem such as the coral reef.

5. Conclusion

Previous meta-analysis has been conducted in environmental economics although is limited in examining the effects/biases in methodology attributes. The empirical results of this study illustrate that, to some extent, the influence biases and/or effects on methodological attributes as recommended by NOAA directives are relevant and significant in influencing the WTP. Consequently, recognizing these influences is essential in survey design and affects the policy application when recreational values of coral reef services are conducted at local, regional and global level.

The implication of methodological effects/biases on WTP estimates implies that the benefit transfer functions need to factor the different methodology characteristics for global sites. In other words, for developing countries the methodological characteristics may differ with developed countries where for the former the stated preference methods are vital to policy application, but however, are far from being a high quality option at a low cost (Whittington, 2002). Importantly, it is worth noting that most developing countries differ from developed countries in their social-economic and political structures, making the NOAA recommendations relatively difficult and costly to implement in the former, as against the latter. Hence, the methodological biases/effects for such countries require more attention, particularly when most coral reefs are dependent on by society located in these nations.

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Appendix

Table 1A: Selected valuation studies included in the meta-analysis [a]

	Author(s)	Year	TCM	CE	CVM	OTH	Region
1	Ahmad and Hanley	2009	0	0	x	0	South east asia
2	Ahmed et al	2007	x	0	x	0	Oceania, mela, micro
3	Andersson	2007	0	0	x	0	Africa, east
4	Arin and Kramer	2002	0	0	x	0	Oceania, mela, micro
5	Barr and Mourato	2009	0	0	x	0	Central america
6	Bell et al	1998	0	0	x	0	N. america, US
7	Beukering et al	2006	0	x	0	0	Oceania, mela, micro
8	Beukering et al	2000	0	x	0	0	Caribbean & small islands
9	Bhat	2003	x	0	0	0	N. america, US
10	Carr and Mendelsohn	2003	x	0	0	0	Australia
11	Casey et al	2010	0	0	x	0	Central america
12	Cesar	2003	x	0	x	0	Europe, south
13	Christiernsson	2003	x	0	0	0	South east asia
14	Dharmaratne et al	2000	0	0	x	0	Caribbean & small islands
15	Dixon et al	1993	0	0	x	0	Caribbean & small islands
16	Edwards	2009	0	0	x	0	Caribbean & small islands
17	Hushak et al	1999	x	0	0	0	N. america, US
18	Johns et al	2004	0	0	x	0	N. america, US
19	Kragt et al	2009	0	0	0	x	Australia
20	Leeworthy and Bowker	1997	x	0	0	0	N. america, US
21	Leeworthy et al	2001	0	0	x	0	N. america, US
22	Lindsey and holmes	2002	0	0	x	0	South east asia
23	Mathieu et al	2003	0	0	x	0	Africa, east
24	McCartney, A	2009	0	x	0	0	Australia
25	Milon	1998	x	0	0	0	N. america, US
26	Mohamed et al	2001	0	0	x	0	Oceania, mela, micro
27	Mohamed, M	2007	0	0	x	0	South asia
28	Morgan et al	2010	x	0	0	0	N. america, US
29	Ngazy, Jiddawi & Cesar	2004	0	0	x	0	Africa, east
30	O'Garra	2009	0	0	x	0	Caribbean & small islands
31	Oh et al	2008	0	0	x	0	N. america, US
32	Park et al.	2002	x	0	x	0	N. america, US
33	Parsons and Thur	2008	0	x	0	0	Caribbean & small islands
34	Pendelton	1995	x	0	0	0	Caribbean & small islands
35	Pham & Son	2001	x	0	x	0	South east asia
36	Ransom and Mangi	2010	0	0	x	0	Africa, east
37	Rolfe and Windle	2010	0	x	0	0	Australia
38	Rudd et al	2001	0	x	0	0	Caribbean & small islands
39	Asafu-Adjaye and Tapsuwan	2008	0	0	x	0	South east asia
40	Samonte-Tan et al.	2007	0	0	0	x	Oceania, mela, micro
41	Seenprachawong, U	2003	0	0	x	0	South east asia
42	Sorice et al	2007	0	x	0	0	N. america, US
43	Spash, C.L	2000	0	0	x	0	Caribbean & small islands
44	Spurgeon et al	2004	0	0	x	0	Caribbean & small islands
45	Subade	2005	0	0	x	0	Oceania, mela, micro
46	Svensson et al	2008	0	0	x	0	South east asia
47	Talaat et al	2009	0	x	x	0	Europe, south
48	Thur, S.M	2010	0	0	x	0	Caribbean & small islands
49	Uyarra et al	2010	0	0	x	0	Caribbean & small islands

50	White, L	2008	0	0	x	0	N. america, US
51	Wielgus et al	2003	0	x	0	0	Europe, south
52	Yacob et al	2009	0	0	x	0	South east asia
53	Yeo	2004	0	0	x	0	South east asia

Note: [a] For the complete citation details these are available on request

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