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Investigating fishers' preferences for the design of marine Payments for Environmental Services schemes

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Abstract

We determine the effects of various management restrictions on adoption rates of marine Payments for Environmental Services (PES) schemes. Choice experiments are used in order to determine how fisher participation rates change under different marine PES programme designs. Various designs, with differing restriction rates, show different rates of adoption. However, fishers show a high utility loss associated with any move away from the current management situation, irrespective of restriction levels. This indicates that PES scheme costs may be high and creating an enabling environment could be important to reducing perceived losses, as could investment into conditional in-kind compensation mechanisms. The paper also shows choice experiments to be a useful tool in marine PES design.

1. Introduction

In the past decade Payments for Environmental Services (PES) have attracted increasing interest as an innovative conservation instrument. PES seek to address market failures whereby environmental services are not attributed their true value, and increase investment into resource conservation. More specifically, PES attempt to capture those economic benefits derived from environmental services, such as clean water, and channel them back to the ecosystem managers who frequently benefit less from resource conservation than alternative land uses (Engel et al., 2008; Pagiola et al., 2005).

PES are defined as a voluntary agreement between a service provider and a service buyer (Wunder 2005). Inducing participation is central to the success of PES as a policy instrument: potential service providers must voluntarily agree to enrol in any programme design (Newton et al., 2012).

Studies relating to PES participation have increased in the past few years. These have mainly been limited to the study of design factors which improve cost-efficiency (Petheram & Campbell 2010), as well as the implications project design can have on equality across stakeholder participation (e.g. Zilberman et al., 2008). More recently, the literature has looked towards addressing the need to understand potential providers' willingness to participate in PES (Newton et al., 2012; Gong et al., 2010; Ma et al., 2010; Petheram & Campbell 2010; Zbinden & Lee 2005). However, these studies have mostly concentrated on describing endogenous individual and household determinants influencing adoption or non-adoption of PES schemes by service providers. While such information can be useful in targeting households and/or communities for PES interventions, these factors are often inflexible and of limited service to policy makers (Ruto & Garrod 2009).

In practice, very few studies have considered those elements of programme design which induce service provider participation. The influence that design factors exert over a scheme's attractiveness have recently received attention within the context of agri-environmental payment schemes (AES) (Ruto & Garrod 2009). AES have much in common with PES in that they are voluntary, incentive-based, conditional and pay for delivery of a desired landscape/land use (Dobbs & Pretty 2008; Ferraro 2008). These recent studies have shown that AES design can indeed influence participation of service sellers. Ruto & Garrod (2009) show that schemes which were designed to be more flexible and offered shorter contracts required lower financial incentives to induce participation. Similarly, Espinosa-Goded et al. (2010) found that those programmes which allowed the maintenance of agricultural activity and did not impose stringent restrictions on farm management were also adopted at lower contract prices. Although not directly relating to AES *per se*, Qin et al. (2011) found that farmers in China were highly concerned with property rights. The provision of priority rights for contract renewal significantly increased farmers' marginal willingness to pay for of existing forestland contracts.

To a greater extent, policy design can be extremely important in achieving adequate acceptance and compliance within the fishery sector and will be particularly important in rural and low-income areas where monitoring and enforcement efforts are often low and/or extremely complex (Lundquist & Granek 2005; McClanahan et al., 2005; Christie 2004). Combined local fishery and conservation goals can be achieved through the merging of diverse management measures. Closed areas and gear modifications jointly will be needed to address wider scale issues of overfishing (Worm et al., 2009). However compliance, particularly in poor and rural settings, will hinge on community acceptance of any conservation modifications. Previous interventions, principally designed with little consensus from local fishers, have largely failed because they were unable to inspire compliance (Ferse et al., 2010; Pomeroy et al., 2001) or cover the opportunity costs of these low-income communities with few alternatives (Mohammed, 2012). For this reason, understanding how local fishers' value management restrictions is of the utmost importance.

Within this paper we concentrate on how the design of PES instruments can influence participation within a marine setting, a topic which, to date, remains largely unaddressed by the PES literature both terrestrially and within the marine context. This paper uses choice experiments (CE) to investigate some aspects of marine PES design. To date there is little application of CE within fisheries management (Wattage et al., 2011), more specifically, how restriction infrastructures may lower or induce participation by local environmental providers. In doing so this paper highlights the importance of community participation and input at the earliest stages of PES design. CE is also shown as a useful tool in assessing service provider trade-offs, and ultimately for marine management design.

The paper proceeds as follows. Section 2 presents a summary of the importance of appropriate instrument design within the marine conservation setting, as well as a review of fisher preferences for management options. Section 3 presents the study area, after which Section 4 introduces the methodological background and the choice model, discusses the use of choice modelling within fisheries management and goes on to describe the choice experiment and the econometric analysis framework in detail. Results are presented in Section 5. A discussion of the findings and their policy implications is found in Section 6. Conclusions are given in Section 7.

2. Fishers and management schemes

Within small-scale artisanal fisheries, marine management has generally favoured regulatory solutions. Of these, the most prolific are MPAs (Agardy et al., 2003). Total prohibition of fishing is ultimately the environmentally optimal management option; evidence of environmental benefits from regulated MPAs is clear (Agardy, 2000). However, MPAs may not be the most economical, nor the more socially just. MPAs can be inefficient and ineffectual, and can further pose unrealistic and unjustifiable burdens on local low-income fishing communities (Cinner et al., 2009a). In reality, MPA success has been mixed: site-selection can favour less accessible and less degraded areas; resource use often leaks into surrounding areas; and designated areas are often too small in area to protect the wider seascape (Cinner 2010; Lele et al., 2010; Graham et al., 2008).

Restrictions on environmentally damaging fishing gears can form another type of conservation intervention; certain fishing gears have a higher propensity over others to negatively impact the marine environment (Akpalu 2010). The use of more destructive gear types can: increase physical damage to the substrate; capture a high proportion of juvenile fish; target species important to reef resilience and deter others from fishing sustainably (Akpalu 2010; Cinner 2010). As such, gear restrictions can be a further effective fisheries management tool and often receive higher support from local fishers (Cinner et al., 2009a). However, the management of artisanal fishers, including the gear they use can be difficult due to their loose, and often poor, organisation (McClanahan & Mangi 2004).

Moving towards more sustainable fisheries often requires a reduction in effort or a switch in methods; both of which pose short-term costs on vulnerable fishers. PES have the potential to complement existing marine management instruments through the provision of short-term incentives. Where local costs are high in the initial stages of restriction measures – whether they be a spatial or gear restriction – PES can assist in compensation for loss of catch, for example. PES should not be viewed as an instrument working in isolation but one that supports current management tools.

Whilst PES may be able to address some of the immediate issues of compensation, they will still need to consider local situations and preferences in order to be successful. Fishers have been documented to hold varying preferences for conservation management restrictions (Cinner et al., 2009a; McClanahan & Mangi 2004). Stakeholder involvement in the early stages of marine conservation development and implementation has been identified as one characteristic of successful approaches (Leslie 2005; Lundquist and Granek 2005). Careful consideration of the receptivity of these communities and fishers to design and implementation of conservation interventions is essential for long-term success (Christie 2004).

Analysis of fisher trade-offs will have numerous benefits. Identification of trade-offs, and resulting design will improve adoption of conservation instrument by local actors. Furthermore, if one assumes that fishers show preferences for the PES design[1] which has the lowest utility cost to them overall, this may lead to more cost-effective PES design.

3. The case study: Mtwara region, Tanzania

Tanzania's coastline supports approximately 25% of the country's 43 million strong population of which a high proportion rely on coastal fisheries as a source of food and income. Most marine extraction activities are conducted within the shallow near shore waters (Gustavson et al., 2009; Silva 2006). As population and fisher numbers continue to increase, these coastal resources come under increasing pressure; Tanzanian marine fisheries have suffered a significant decline in biodiversity and productivity in the past three decades (Silva 2006).

Located in the south of Tanzania, Mtwara's coastal waters are of high national and international importance. The area contains some of Tanzania's most significant biodiversity. Part of the Eastern African Marine Ecosystem (EAME), its coral reef,

[1] PES design is considered herein to include various levels of restrictions faced by fishers. This will include facets of MPA restriction such as area under closure as well as further restrictions placed on gear. In reality MPA design will be an integral part of PES design, whereby PES refers to the addition of a compensation mechanism to restricted extraction and/or access.

which extends south from neighbouring region Lindi to the Mozambican border, connects with the Mozambican Quirimbas reef system. Together these reef systems are of critical importance as sources of marine larvae and spores which disperse out to northern and southern marine ecosystems; the Southern Equatorial Current diverges in this area creating an area of high replenishment capability (Shao et al., 2003; WWF 2004). At the same time, the area supports a large human population. With poor transport infrastructure, marginal soils and high levels of illiteracy and poverty as the norm, Mtwara's coastal community is highly dependent on marine resources (Gustavson et al., 2009; Malleret 2004).

In response to increasing environmental threats and high biological significance, the Tanzanian government gazetted Mnazi Bay-Ruvuma Estuary Marine Park (MBREMP) in 2000. Formed under the Marine Parks and Reserves Act (1994), MBREMP is under the control of the Marine Reserves Park Unit (MRPU). Outside of the marine park fishery enforcement falls under the mandate of the Fisheries Division of the Ministry of Natural Resources and Tourism. The MRPU's mandate is to establish and ensure sustainable conservation of areas of outstanding marine ecological importance, and to manage them in partnership with the coastal communities. Management activities include patrolling of enforced no-take zones and gear restrictions; these are supported through the enactment of village and district by-laws (Silva 2006). However, the park has met some community resistance, both within and outside of its borders due to local perceptions of loss, particularly through tighter enforcement of gear restrictions.

MBREMP is effectively a multi-purpose marine park, and continues to allow fishing within its borders. Regulations within the park are essentially the same as those outside, albeit enforced more frequently. These include: prohibition of certain destructive gears such as beach seine nets and dynamite; mangrove cutting for commercial sale; and the use of nets with meshing smaller than 3" (Robinson et al., 2012).

4. Methodology: choice experiments

Understanding how fishers' perceive the loss associated with various fishing restrictions as well as their preferences for alternative management strategies will serve to improve PES design and compliance. To test fishers' preferences for various PES management options, and investigate the trade-offs between these options, we implement a CE (Bateman et al., 2002; Louviere et al., 2000).

A survey-based stated preference (SP) technique, CE presents respondents with several choice sets, each containing a set of mutually exclusive hypothetical alternatives, and asks them to choose their preferred alternative in each choice set. Each alternative is described by a set of characteristics, known as attributes (Blamey et al., 2000; Mangham et al., 2009), which take on different levels. Choices between the alternatives reveal respondents' implicit trade-offs between attribute levels (Louviere et al., 2000).

Unlike the more commonly used contingent valuation method, CE enables environmental changes to be described and valued in terms of a specific set of characteristics. With the inclusion of a cost or payment attribute, marginal utility estimates can easily be converted into willingness to pay (WTP) or willingness to accept (WTA) estimates for changes in attribute levels. In this way, information can be gathered on: (a) those attributes which are significant determinants of the 'good'; (b) the relative importance of individual attributes; (c) an individual's marginal rate of substitution between attributes; and (d) the associated utility cost or benefit of each of the different combinations of attributes (Louviere et al., 2000; Wattage et al., 2005).

SP approaches have received much debate regarding their merits and limitations within the academic literature. Much of this criticism centres on the technique's hypothetical nature. Hypothetical bias arises when people overstate their WTP for a good due to the absence of real economic commitments (Mitchell and Carson 1993; Neill et al., 1994). This bias has been shown to be higher for those respondents who are less knowledgeable, for unfamiliar changes and for voluntary payments vehicles, such as WTA rather than WTP formats (Atkinson & Mourato 2008). In addition, CE have been criticised for increasing the cognitive burden placed on the respondent; the attribute-based contingent scenarios may be more complex and there is a limit on the amount of information respondents can meaningfully handle while making a decision. This in turn can give rise to further problems of: learning and fatigue effects leading to apparently irrational choices; increased random errors associated with complexity of task; and satisficing rather than utility-maximising behaviour (Hanley et al., 2001).

As with other SP methods, CE success depends critically on having an accurate, meaningful and understandable scenario; hence careful survey design is essential. The additional information that CE can glean about respondent's preferences has led to many viewing CE as having an advantage over contingent valuation. Indeed, over the last decade, CE has been increasingly used to value the effects of changes in environmental attributes, and, more recently, different characteristics of policy design (Ruto & Garrod 2009; Hanley et al., 2003).

4.1 CE and fisheries management

To date there has been little application of CE within fisheries management (Wattage et al., 2011). Of notable exception are the works of Wattage et al. (2011; 2005) and Aas et al. (2000). Wattage et al. (2011) uses a CE approach to determine the economic value held by the Irish public for the conservation of deep-sea corals using MPA variant management options. Wattage et al. (2005) demonstrated the applicability of CE in the evaluation of three over-riding management options and its ability to offer meaningful information to the management process. Furthermore, Aas et al. (2000) showed CE to be particularly useful in the evaluation of various fishery management options for harvest regulation within a Norwegian recreational fishery. However, despite growing application in the industrial fishing arena, CE has been little used within low-income rural settings, terrestrially and indeed coastally (Glenk et al., 2006).

4.2 CE design

Questionnaire design followed the principles laid out by Bateman et al. (2002). Alongside the CE, surveys collected data on: individual and household demographics; household assets; attitudes relating to fishing, environment and conservation; and fishing practices, income and livelihood diversification strategies.

The CE revolves around fishers' preferences for various PES management restrictions. After reading a scenario relating to the implementation of a prospective PES programme, respondents were presented with a series of choice sets, illustrating possible PES programme options, and asked to choose their most preferred. The hypothetical options were presented as possible governmental and marine park authority PES conservation programmes[2]. The following sections describe the key

[2] Within Tanzanian marine parks fishing rights are controlled by the Marine Park Authority; however, outside the marine park, boundaries management is in the hands of the Tanzanian Government fisheries division.

elements of the CE: the selection of attributes and levels of the possible PES scheme, the experimental choice card design, the scenario, and the data collection process.

4.2.1 Attribute and levels selection

The first step in implementing the CE is the determination of realistic attributes and attribute levels which define the good to be valued (Mogas et al., 2006; Bennett & Blamey 2001; Hanley et al., 2001). The good here is a hypothetical marine PES management plan that comprises two restriction attributes and a payment attribute.

The CE attributes and levels used are displayed in Table 1. The selection of relevant attributes and attribute levels was based on information gathered from peer-group meetings and semi-structured interviews, from current management options, as well as management options that an implementing organisation would be able to influence through policy design. Peer-group meetings and interviews were conducted within each of the six fishing communities chosen for research (see 4.2.4 below) and were further sub-divided for fisher-types. Appropriate marine management restrictions were thus selected based upon importance to fishers, as identified in community focus groups and interviews, as well as to fit relevant locally applicable management options[3].

In order to minimise issues of cognitive burden, particularly within communities unaccustomed to CE techniques, management scenarios were constrained to the two most relevant attributes which emerged from group meetings and interviews: gear restrictions and area closures. Both these management measures are considered to be credible and realistic for the areas in question; past governmental interventions have in fact involved net restrictions and marine zone closures. A third attribute relating to the compensation payment package (i.e. the monetary incentive of the PES scheme) was further included. The payments were described as weekly compensation payments for changes brought on by PES management design. All attributes and attribute levels were piloted. After the first round of pre-testing, the compensation payment attribute levels were found to be too low and suitably adjusted.

Table 1. Attribute and attribute levels in choice model experiment

[3] MRPU management activities currently include patrolling of enforced no-take zones and gear restrictions. These are supported through the enactment of village and district by-laws (Silva 2006).

PES scheme attribute	*Description*	*Attribute level*
Size of no-take area	Area as % of current fishing area in which fishing will no longer be permitted and declared MPA.	0, 10, 25, 50
Size of permitted net meshing	Net mesh size in inches permitted that fishers are permitted to use within fishing grounds. Mesh size is measured as size when mesh pulled at each corner.	1, 3, 6
Payment	Weekly payment in Tanzanian Shillings (TSh) made under PES scheme[4]. [a]	-1000, 5000, 10,000, 20,000

[a] Payments reported as US$ equivalent where US$ 1 is equal to 1450 TSh.

Large differences were noted in the PES management attributes fishers preferred. At some levels certain restrictions were considered highly beneficial to some fishers while highly detrimental to others, e.g. some fishers preferred smaller net meshing while others favoured larger nets. Some fishers were found to be willing to pay for 'more attractive' management options such as the legislation of small meshed nets. As such an additional negative compensation payment option (-1000 TSh) was included alongside positive compensatory payments (Table 1). This would assess if some fishers valued these losses highly enough to be willing to accept negative compensation or, in other words, to be willing to pay for the instatement of 1″ nets, which are currently illegal.

4.2.2 *Experimental choice card design*

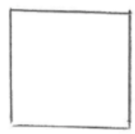
Generating all possible combinations of attribute levels across all three chosen attributes produced a total of 48 possible PES management scenarios (i.e. 4 levels of the no-take area size attribute * 3 levels of the mesh size attribute * 4 levels of the payment attribute). It was considered excessive to use the full-factorial design in the field and so possible management alternatives were reduced to 16, using an orthogonal fractional factorial design (Louviere et al., 2000). From such a design it is possible to obtain what are known in the literature as 'main effects'; that is the extent to which variations in behaviour can be explained purely by the levels of each of the individual attributes presented. Louviere (1988) states that more than 80% of respondent behaviour can typically be explained in terms of main effects alone.

[4] Payments reported as US$ equivalent where US$ 1 is equal to 1450 TSh.

It was then noted that the combination of small 1″ nets with a negative compensation payment (i.e. representing fishers willing to pay for the implementation of this regulation) was not present within the 16 scenarios selected via orthogonal design (that is, negative payments were only included for 3″ and 6″ nets), although this was a management option which many fishers seemed to prefer during piloting as noted above. Therefore, two additional scenarios were included in the final CE design which combined the negative compensation value (-1000TSh) with small meshing 1″ nets (and various degrees of closure: 0 & 10%). A total of 18 management scenarios were therefore used in the final experiment. [5]

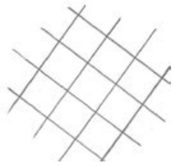
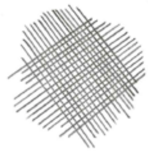
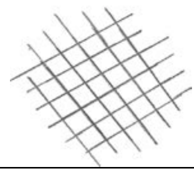
The 18 experimentally designed management scenarios were then organised into a series of choice sets. Each choice set contained three PES management options: two of the experimentally designed alternatives described above (Cards 1 and 2), to which the current status quo baseline scenario was added (Card 3). Choice cards 1 and 2 were picked at random by the enumerator without replacement from a bag containing all 18 scenario cards (Louviere et al., 2000). The scenarios presented in the choice sets were unlabelled, i.e. generic[6]. Each respondent was presented with six of these randomly generated choice set triplets, which was the maximum deemed feasible in the circumstances. A choice set example is illustrated in Figure 1.

Fig 1 Example of choice set

Attributes	***Management Option 1***	***Management Option 2***	***Status Quo***
Closure % closed of current fishing grounds	10 	50 	0 
Net	6	1	3

[5] It should be noted that through the addition of two extra cards, the final set of cards presented is not fully orthogonal in design. However, when analysis is undertaken using a logit regression framework, as in the present case, orthogonality although desirable is no longer essential for the method to work satisfactorily. Hence the inclusion of these additional cards should not have a marked impact in the parameter estimates.

[6] See Louviere et al. (2000) and Fimereli and Mourato (2013) for a discussion and examples of the differences between labelled and unlabelled alternatives in choice experiments.

mesh size in “			
Payment (TSh)	10,000	5,000	0

As described in Section 4.2.1 and depicted in Fig. 1, each scenario was described by three attributes: the possible size of marine area to be designated as a no-take zone, gear restrictions placed on allowable net sizes (i.e. size of mesh), and a monetary compensation. The monetary compensation was offered as a weekly sum in local currency (Tanzanian Shillings: TSh) but is reported within the results below as the US$ equivalent.

In order to improve respondents’ understanding of the management scenarios presented and improve familiarity with possible changes, visual aids were used to represent attributes and attribute levels (Fig. 1).[7] Visual aids have been shown to reduce task complexity and improve choice by increasing understanding within low-literacy respondents (Jae and DelVecchio, 2004).

Fishers were also run through an example before starting the CE as further explanation and for enumerators to judge fisher comprehension.

4.2.3 *The scenario*

In order for any CE to be relevant it must be understandable and meaningful to the local area. As noted above, the scenario here is a hypothetical marine PES management plan that comprises two restriction attributes and a payment attribute. Specifically, the hypothetical scenario was presented to fishers in the following way:

“I want you to think about the current law and about further prohibitions in your fishing area, more specifically the introduction of additional no-take zones and the prohibition of certain gears. These changes come with compensation for these additional restrictions.

I am going to show you three choice cards. Two cards will show you new fishing regulations and the third card shows you the current regulation in your fishing area.

[7] This is particularly important as education levels among the fishers in our sample were found to be low: 96.2% claimed to have no formal education or attended school only at the primary level.

Each card has two attributes relating to the possible changes in law which can change:

- *The percentage of your current fishing area to be closed to fishing*
- *The allowable net mesh size (in inches)*

The final attribute on these cards is a monetary value. This is the level of compensation per week you would receive if these restrictions were put in place. Please remember, the values shown in BLUE are payments you would receive. Values shown in RED are payments you would make each week to have the new restrictions put in place.

Monitoring and enforcement would be a collaboration between the community and the Marine Park Authority/Beach Management Unit. Payments would be made monthly and all payments would be withdrawn if the restrictions were not followed.

Please consider carefully which of the scenarios on the cards you prefer, thinking about how each restriction would effect your fishing catch, the compensation you would receive and the trade-offs between the three."

Following this explanation of the hypothetical PES scheme and the choice cards, respondents were then presented with six choice sets, each containing 3 choice cards as exemplified in Fig.1.

4.2.4 Data collection

Primary data was collected from six coastal villages located within the Mtwara region of southern Tanzania. A marine PES scheme will require participation by all marine resource users so it was important to collect data across a variety of village types. Villages were therefore selected to give a representative sample of the area and were selected from both within and outside of the Park boundaries.

Face-to-face interviews were administered with local fishers by trained local enumerators. After an initial round of piloting, fisher surveys including the CE were conducted with village fishermen between April and July 2010. Initially fishers were targeted using random selection from lists provided by the local village leaders. However, it quickly became obvious that fishers' unpredictability meant a less probabilistic sampling method was necessary. Initial pilot meetings identified some fishers to be sampled; further fishers were selected within villages and landing sites using a non-probabilistic opportunistic sampling method. A total of 317 fishers provided complete answers to the questionnaire.

4.3 CE analysis

As noted above, the CE was designed to identify fishers' valuations of two different attributes of the PES management schemes: net size, and closure. Each fisher was presented with six sets of three management alternatives (two new alternatives vs. the status quo), with each alternative being defined by its combination attribute levels.

In order to analyse choices between three or more alternatives as a function of the attributes of the alternatives as well as the characteristics of the individual making the choice a conditional logit model (CLM) is used. The CLM estimates the probability that individual *i* chooses alternative *j*, as described by McFadden (1974):

$$\Pr(Y_i = j) = \exp(\beta' z_{ij}) \Big/ \sum_j \exp(\beta' z_{ij}) \tag{1}$$

where z_{ij} represents both the individual i's characteristics and the choice-specific attributes. Any variables that do not vary across alternatives, such as individual-specific socio-economic characteristics and fisher types, drop out of the model unless they are interacted with variables that are alternative-specific, such as the attributes of the alternatives (Hensher et al., 2005)

The CLM assumes homogenous preferences across respondents and independence from irrelevant alternatives (IIA[8]). More specifically, the CLM: (1) can represent systematic but not random taste variations (e.g. those that can be linked to observed respondent characteristics but those which cannot be linked and cannot be explicitly modelled); (2) displays restrictive substitution patterns (e.g. assumes all pairs of alternatives are equally similar or dissimilar); and (3) is able to model situations where unobservable influences are independent but unable where correlation is generated between alternatives (Hoyos 2010; Hensher et al. 2005).

The choice sets presented to fishers (as described in Section 4.2.2) show three management scenarios, two which represent the introduction of new regulations plus the status quo (no additional restrictions). As such it is possible that respondents

[8] IIA states that the ratio/likelihood of choosing any two choice options will be unaffected by the attributes or availability of the other options present, that is that the ratio of probabilities of any two options is independent of the choice set (Hausman and McFadden, 1984). Put more simply, all pairs of alternatives are equally similar or dissimilar (Hensher et al. 2005).

choose their preferred management option using a two-stage process. That is, in the first instance, respondents choose between supporting or not-supporting a new 'improved' management scheme. If a change to the current marine management is chosen, respondents then choose between new management Option 1 and 2. This choice path is illustrated in Figure 2. This implies that the ratio of the choice probabilities for any two alternatives would be affected by the addition or removal of one set of alternatives and as such violates the IIA assumption, rendering the CLM inappropriate (Blamey et al. 2000).

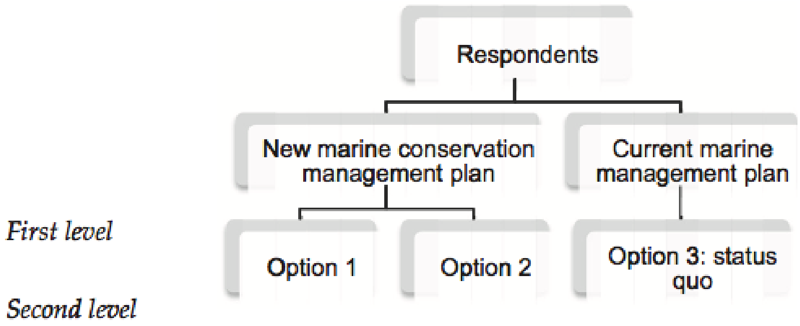


Fig. 2. Illustration of the nested logit model choice path.

In order to accommodate possible IIA violations within the CE, a nested logit model (NLM) can be used. The NLM avoids the need to rely on IIA by modelling choices in a hierarchical nested structure. This device allows error terms across choices within each 'nest' to be correlated with one another, although choices across 'nests' are still assumed to be uncorrelated (Heiss, 2002). Error terms are assumed to follow a Type B Gumbel extreme value distribution as shown in equation (2) (as opposed to the conventional extreme value distribution assumed for the CLM model). The degree of correlation between the error terms is captured by the parameter ρ. Indeed, the CLM can be regarded as a special case of this model when the parameter ρ takes a value of one.

$$f(e_1 \dots e_J = \exp\{-[\exp(-\rho^{-1} e_1) + \dots + \exp(-\rho^{-1} e_J)]\}^{\rho} \qquad (2)$$

In a two tier choice structure, the probability of choosing a particular alternative k out of the n second stage options, conditional on having selected a particular alternative j out of the m first stage options, can be expressed as indicated in equation (3). The logarithm of the denominator of this expression is known as the *inclusive value* (I), because it summarises the information about the alternatives included in this lower nest. Inserting this inclusive value as an explanatory variable in the first stage of the decision tree yields the expression for the unconditional probability of choosing option *j* out of the *m* first stage options, given in equation (4).

$$P(k \mid j) = \frac{\exp(b_{k|j} X_{ik})}{\sum_n \exp(b_n X_{ik})} = \frac{\exp(b_{k|j} X_{ik})}{\exp I_{k|j}} \quad (3)$$

$$P(j) = \frac{\exp(c_j X_{ij} + \rho I_{k/j})}{\sum_m \exp(c_m X_{ij} + \rho I_{k/j})} \quad (4)$$

The model can be estimated by maximising the log-likelihood function is as stated in equation (5), where *y* is an indicator variable which takes a value of one when person *i* chooses option *k* (and thus, by implication, option *j*).

$$\log L = \sum_i \sum_k y_{ik} \log[P(k \mid j) P(j)] \quad (5)$$

Like the CLM, the NLM only uses information on the first best option identified in each choice set.

Data is analysed in the first instance using the CLM as well using a NLM where appropriate. Models are estimated using STATA 11 software.

All variables used within the econometric analysis are listed in Table 2. Attributes closure and payment entered the models as continuous variables. A large dichotomy was seen in preferences for small meshing between fishers so 'Size of permitted net meshing' (Table 1) was entered as two dummy variables (Table 2): 'Net_{small}' where minimum legal meshing was 1″ and as 'Net_{large}' where minimum legal meshing was 6″. These dummies were contrasted to the baseline of 3″ mesh size as this is the current legal status quo.

A modelling constant, i.e. an alternative specific constant (ASC) for choosing the status quo alternative, was included in the models (Table 2). The role of the ASC is to account for any unobserved variation in choices that cannot be explained by either the attributes or socioeconomic determinants.

Table 2. Variable list and descriptive statistics of independent variables

Variables	*Definition*	*Mean*	*SD*	*min*	*max*
Closure	Continuous variable for % marine area designated no-take zone and closed to fishers relative to current fishing grounds: 0; 10; 25 & 50% closure.	13.5	17.9	0.0	50.0
Net_{small}	Dummy for net with 1" mesh size	0.2	0.4	0.0	1.0
Net_{base}	Dummy for net with 3" mesh size, current Tanzanian legal mesh size	0.7	0.5	0.0	1.0
Net_{large}	Dummy for net with 6" mesh size	0.2	0.4	0.0	1.0
Payment US	Weekly payment offered as compensation for implementation of new management scenario. Payment transformed into US $: -0.690; 3.448; 6.897; 13.793.	3.7	5.1	-0.7	13.8
ASC	Dummy for Alternative Specific Constant/ choosing of status quo	0.3	0.5	0.0	1.0
Demographics					
Age	Age of respondent (years)	35.0	12.7	16.0	82.0
Edu	Count variable for respondent's level of education: 2= attended secondary or above; 1= attended primary; 0 = no education	0.7	0.5	0.0	2.0
Inc	Continuous variable for respondent's annual income from fishing (US $)	862.7	1,215.4	0.0	10,925.0
inpark	Dummy for location: village found inside park borders =1; village located outside =0	0.6	0.5	0.0	1.0
illegal	Dummy for those fishing having used illegal fishing methods: 1=fish illegally; 0=fish legally	0.2	0.4	0.0	1.0
land	Continuous variable for area of land owned in ha; used as proxy for reliance on fishing whereby those with larger holding are assumed to have lower reliance of fishing	2.1	5.7	0.0	60.0

5. Results

5.1 Descriptive results

After exclusion of incomplete questionnaires and initial pilots, the sample size was 317 fishers.

Table 3 displays the key demographics for the final sample as broken down for villages and overall. Average fisher age was 35 years and household size was 4.9. Education levels were low across all villages; in all villages, fishers whom had attended secondary school was lower than 7% of the final sample. Table 4 indicates the mean fishing characteristics of sample respondents by village, as well as grouped for in and outside of the park. Villages appear to have apparent disparities between fishing and non-fishing income activities across villages. For example, average fishing income was as high as US$ 4.81 a day in Pemba but as low as US$ 1.31 in Mngoji. Furthermore, the number of fishers with other income sources also varied across villages, Mkubiru indicated 71% of fishers claimed non-fishing income revenues; in Pemba village this figure was only 26%. These results could highlight different levels of dependence on fishing as a livelihood.

Table 3. Mean demographic characteristics of sample respondents

	In			*Out*			*All*	*In*	*Out*
	Mkub	*Mngj*	*Msim*	*Mkdn*	*Naum*	*Pemb*			
No.	75	39	62	33	58	50	317	176	141
Age	35.5	37.3	32.9	43.0	33.6	33.5	35.3	35.0	35.7
HH_size	4.6	5.4	4.3	5.5	5.5	4.4	4.9	4.7	5.1
Education (% sample)									
None	25.3	18.0	38.7	36.4	27.6	24.0	28.4	28.4	28.4
Primary	69.3	79.5	58.1	63.6	65.5	74.0	67.8	67.6	68.1
Secondary or above	5.3	2.6	3.2	0.0	6.9	2.0	3.8	4.0	3.5

Where: In=villages located in park, Out=villages located outside of park; Mkub=Mkubiru, Mngi=Mngoji, Msim=Msimbati, Mkdn=Mikindani, Naum=Naumbu, Pemb=Pemba.

Table 4. Mean fishing and alternative occupation characteristics of sample respondents

	In			*Out*			*All*	*In*	*Out*
	Mkub	*Mngj*	*Msim*	*Mkdn*	*Naum*	*Pemb*			
Fishing income as daily wage:	2.4	1.6	1.3	2.6	1.9	4.8	2.4	1.9	3.1
Weekly fishing income	17.1	11.0	9.2	18.6	13.4	33.8	17.1	13.1	21.8
% with non-fishing income source	0.7	0.5	0.3	0.3	0.4	0.3	0.4	0.5	0.3

Average area of cultivated land	2.0	3.3	2.8	2.6	1.2	0.9	2.1	2.6	1.4
% currently employing illegal gears	0.3	0.1	0.2	0.3	0.1	0.0	0.1	0.2	0.1
% who in past employed illegal gears	0.5	0.8	0.6	0.5	0.7	0.7	0.6	0.6	0.4

Where: In=villages located in park, Out=villages located outside of park; Mkub=Mkubiru, Mngi=Mngoji, Msim=Msimbati, Mkdn=Mikindani, Naum=Naumbu, Pemb=Pemba.

5.2 Econometric results

As noted, 317 fishers completed the choice task and accompanying survey. Of these, 221 respondents (70.0%) made at least one choice which was a deviation from the status quo (i.e. alternative A or B in the choice set). 96 fishers chose the status quo in all six choices. Of these 96, 68 respondents perceived the status quo to be their preferred option, the main reasoning being a dislike of any form of marine closure. The remaining 28 respondents (8.8% of the final sample) were considered to be protests and dropped from the final analysis. Protest votes arise when respondents do not state their true preferences which can lead to bias in the final utility estimates. Protests were considered those respondents who selected the status quo in all choice sets, made at least one irrational choice and provided no follow up explanation for choices made.

5.2.1 The base model

The main estimation strategy relies on the NLM. While the conditional logit assumes uncorrelated errors, the nested logit specifies the error structure more flexibly and allows some correlation within parent-levels. A log likelihood test indicated the IIA hypothesis could be rejected (p-value 0.088); as such the NLM is favoured over the simpler CLM model. Analysis revealed broadly consistent results across both models, with slight adjustments in attribute coefficients.

The base model results (i.e. model containing attributes only) are reported in column 1 of Table 5. Column 2 reports the results of the CLM for comparison.

Table 5. Model estimates for base specification

	Base model: nested		***Base model: conditional***	
	Coeff	SD	Coeff	SD

Closure	-0.010	***	0.003	-0.013	***	0.003
Net_small	0.075		0.109	0.112		0.127
Net_large	-0.573	***	0.126	-0.700	***	0.119
Payment_US	0.061	***	0.009	0.072	***	0.007
ASC	0.780	***	0.144	0.957	***	0.107
Log-L		-1623.7652			-1625.2184	
Adj-Pseudo R2					0.1308	
Waldchi		62.05			250.69	
Prob >chi		0.0000			0.0000	
N (choices)		5106			5106	
N(cases)		1702				
LR test for IIA P>chi2		0.088				

Robust standard errors have been used. (*) denotes significance at the 10% level, (**) at the 5% level and (***) at the 1% level.

The results reveal that the varying attribute levels influenced willingness to adopt PES schemes. Size of marine closure and having 6” net meshing were negatively associated with willingness to enrol in marine PES (-0.013, p<0.01 and -0.700, p<0,01 respectively). The magnitude of payment offered by the scheme was also a significant determinant and, as expected, showed a positive relationship with willingness to enrol (0.072, p<0.01). The possibility of a PES management scheme which allowed the use of extremely small mesh sizes did not appear to significantly influence fisher’s choice. The results indicate fishers show a preference for PES schemes which have smaller no-take areas and that allow the medium mesh size (3”). However, increasing payment associated with PES scheme will enable greater restrictions to be placed upon the conservation area, such as larger no-take zones and mesh sizings. The trade-offs between these attributes are discussed later in the paper.

The ASC was also seen to enter positively and significantly, that is after controlling for all attributes respondents were still more likely to pick the status quo. This indicates a general preference overall for the status quo, and an overall reluctance to engage with management changes.

5.2.2 Implicit prices

Inclusion of the payment term within the model enables estimation of the marginal rate of substitution (MRS) between attributes and compensation levels, and indicates the monetary utility loss associated with each management restriction.

Implicit prices are expressed in Table 6. As the NLM assumes a linear utility function, implicit prices (IP) are expressed as the ratio of the attribute of interest's coefficient and that of monetary value (Bennett & Blamey 2001).

$$IP = -\beta_{\text{non-marketed attribute}} / \beta_{\text{marketed attribute}} \tag{7}$$

Table 6. Implicit prices: WTA

	Base model: nested	*Base model: conditional*
Closure (US$/10% additional closure)	1.583	1.808
Net_small (3″ decrease to 1″net)[9]	-1.222	-1.543
(US$/1″ reduction in length of mesh)	*-0.611*	*0.772*
Net_large (3″ increase to 6″ net)	9.351	9.674
(US$/1″ additional length of mesh)	*3.117*	*3.225*
ASC	12.721	13.239

As can be seen from Table 6, when all other variables were held constant, closure of an additional 10% of seascape would require an additional US $1.60 a week in compensation. Interestingly, additional net mesh restrictions appear to represent a higher utility cost in comparison. In order to gain acceptance of increased mesh restrictions of 3″ to 6″ minimum size, weekly compensation of almost US$ 10 per fisher is required; and a 1″ increase requires US$ 3.20.

Deviation away from the status quo indicated the highest loss to fishers and indicated an implicit price of US$ 12.72[10].

5.2.3 *Economic surplus*

The economic surplus associated with the implementation of each new alternative management option in contrast to the current status quo can be calculated using equation (8) below (Bennett & Blamey 2001)[11].

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[9] Deviation to small meshing is also displayed although it should be noted that within the base model this variable was seen to be a non-significant determinant.

[10] Calculated from equation (6) where ASC=0.7797918/0.0612984 = 12.72

[11] The ASC parameter is often ignored in CE welfare measures however conceptually the ASC effect is a component of the indirect utility function and should be included. The ASC can account for unobserved attributes which are known to the individual but not the researcher as well as a 'pure' preference for the current situation (Boxall et al. 2009; Bennett & Blamey 2001).

$$\text{Economic surplus} = -(1/\beta_{monetary})(V_A - V_0) \quad (8)$$

When:

$$V_A = \text{Alternative} = \beta_1 \text{Closure}_A + \beta_2 \text{Net}_A$$

$$V_0 = \text{StatusQuo} = \text{ASC} + \beta_1 \text{Closure}_0 + \beta_2 \text{Net}_0$$

Table 7 displays the economic surplus of all possible combinations of management strategies associated with the various PES management scenarios.

Table 7. Economic surplus under differing management options: US$ -/week

Mesh size (“)	*Size of closure* (% closure current fishing grounds)			
	0	**10**	**25**	**50**
1	-11.499	-13.082	-15.457	-19.414
3	-	-14.304	-16.678	-20.635
6	-22.072	-23.655	-26.029	-29.987

As expected the greatest utility loss is associated with those management options with the greatest restrictions. Only one management strategy indicated a lower loss, this was via the introduction of smaller meshing and with no closure; however again it should be noted that a deviation from the current 3″ meshing to 1″ was not a significant determinant. Interestingly, fishers perceived restricting net meshing to 6″ would lower their utility slightly more so than a closure as large as half their current fishing grounds, although overall the two were broadly equal in utility loss (a utility loss of 22.1 vs. 20.6).

5.2.4 Trade-offs between restriction types

In order to understand any trade-offs being made between the two restriction types, a further analysis was conducted. Trade-offs are calculated using a similar deviation as for implicit pricing whereby the willingness to trade-off between any pairs of attributes is the ratio of these attributes as shown below.

$$\text{Trade off} = \beta_{\text{non-marketed attributeA}} / \beta_{\text{non-marketed attributeB}} \quad (9)$$

Results are presented in Table 8. From the data, it appears that fishers approximately equate a twenty percent closure as similar in utility loss to that of a 1″ increase in allowable mesh size from the current 3″ net.

Table 8. Trade-offs analysis

	Base model: nested
Closure/Net_large:	0.508
(10% additional closure)/ 1″ additional length of mesh)	
Net_large/Closure:	1.969
(1″ additional length of mesh)/ (10% additional closure)	

5.2.5 *Predicted probabilities: accepting PES design*

Predicted rates of adoption are estimated for a number of various PES management scenarios from the base model and displayed in the following tables[12]. Tables 9a-c indicate the predicted probabilities of various PES management designs. Table 9a and 9b display those management designs with only one restriction from the current status quo under the minimum and maximum payment option. Table 9c shows the predicted probabilities associated with mixed restrictions under the highest payment.

As can be seen in Tables 9a-c uptake of schemes shows high variability dependent upon attribute levels and payments offered. Offering weekly compensation values of 5,000 TSh (US$ 3.5) (Table 9a) appeared too low to promote reasonable adoption of the PES schemes investigated; only approximately half of the population would be willing to sign on for the PES design with the lowest restriction of a 10% closure. Raising the weekly compensation payment from US$ 3.5 to US$ 13.8 increased predicted adoption to 70% (Table 9b) under this least restrictive scenario.

[12] Predicted probabilities are produced using the CLM due to its relative ease of calculation and because results are consistent across both CLM and NLM.

Table 9
Acceptance probabilities under differing PES management scenarios.

a. Management scenarios with one restriction and minimum payment

Attributes	PES restrictions			
	10% closure only/min payment	25% closure only/min payment	50% closure only/min payment	Zero closure/increase to 6 in. mesh/min payment
Closure (% total area)	10	25	50	0
Mesh size (in.)	3	3	3	6
Payment	5000 TSh (US$ 3.45)	5000 TSh (US$ 3.45)	5000 TSh (US$ 3.45)	5000 TSh (US$ 3.45)
Predicted probability of adoption	53.0	48.1	40.0	38.9

b. Management scenarios with one restriction and maximum payment

Attributes	PES restrictions			
	10% closure only/max payment	25% closure only/max payment	50% closure only/max payment	Zero closure/increase from 3 to 6 in. mesh/max payment
Closure (% total area)	10	25	50	0
Mesh size (in.)	3	3	3	6
Payment	20,000 TSh (US$ 13.79)	20,000 TSh (US$ 13.79)	20,000 TSh (US$ 13.79)	20,000 TSh (US$ 13.79)
Predicted probability of adoption	70.4	66.2	58.5	56.4

c. Management scenarios with joint restrictions and maximum payment

Attributes	PES restrictions		
	10% closure/increase from 3 to 6 in. mesh/max payment	25% closure/increase from 3 to 6 in. mesh/max payment	50% closure/increase from 3 to 6 in. mesh/max payment
Closure (% total area)	10	25	50
Mesh size (in.)	6	6	6
Payment	20,000 TSh (US$ 13.79)	20,000 TSh (US$ 13.79)	20,000 TSh (US$ 13.79)
Predicted probability of adoption	54.2	49.3	41.2

However, even with such a minimal restriction, 30% of the sample respondents were unwilling to participate. This value rises to approximately 55% for the two harsher restrictions of a 50% closure or a restriction on net mesh size of <6″ independently, even when the highest compensation value was offered (Table 9b). One might expect that these relatively low predicted probabilities are due to a high utility cost associated with any move away from the status quo (ASC).

Again, the predicted probabilities associated with those PES schemes utilising a mixture of restrictions are also low, despite the higher compensation offered (Table 9c). Unfortunately the high utility associated with an increase to 6″ in net mesh size may override any major trade-off benefits being seen. For example, implementing a 10% closure alongside the 6″ mesh restriction reduces the adoption rate by only 2.2%. While this is a good outcome for the implementation of a mixed PES scheme, adoption rate is still very low due to the resistance against increased net restrictions and again the initial move away from the status quo.

5.2.6 Robustness check

A selection of socio-demographics variables as described in Table 4 were added in an extension to the original model in order to test the robustness of the model findings.

Results are shown in Table 10. With inclusion of socio-demographic variables, results remain broadly consistent; all significant attributes retain significance albeit to a lesser extent.

Small mesh size 1″ (Net_{small}) enters the model as positive and significant at the 10% level, indicating a preference for smaller nets within management scenarios by some fishers. An interaction term between age and Net_{small} (age_netsm) further suggests that younger men prefer this option. Income interacted with a dummy for the larger 6″ nets (inc_netlg) indicates that higher earners are more likely to prefer PES management scenarios which increase mesh net restrictions to 6″.

The ASC drops out as significant once socio-demographics are entered. Income enters as a significant positive determinant of a preference for the status quo and management options which include a movement to larger net meshing.

Table 10. Robustness check: model extension with socio-demographic controls

	Base model: nested			***Base model: conditional***		
	Coeff		SD	Coeff		SD
Closure	-0.018	**	0.008	-0.024	**	0.009
Net_{small}	0.611	*	0.359	0.792	*	0.456
Net_{large}	-0.626	*	0.323	-0.774	*	0.406
Payment_US	0.066	***	0.022	0.083	***	0.026
ASC	0.304		0.354	0.563		0.369
Age_close	2.5e-04		1.5e-04	2.7e-04		2.0e-04
Age_netsm	-0.017	**	0.008	-0.022	**	0.010
Age_netlg	0.003		0.007	0.002		0.009
Age_pay	-1.7e-04		4.6e-04	-1.4e-04		5.7e-04
Age_ASC	0.007		0.008	0.005		0.008
Edu_close	-8.6e-04		0.004	3.4e-04		0.005
Edu_netsm	-0.091		0.186	-0.094		0.238
Edu_netlg	-0.271		0.178	-0.317		0.225
Edu_pay	0.005		0.012	0.007		0.014
Edu_ASC	-0.025		0.189	-0.006		0.202

Inc_close	1.5e-06		2.2e-06	9.8e-07		2.6e-06
Inc_netsm	1.2e-04		1.0e-04	1.7e-04		1.3e-04
Inc_netlg	2.3e-04	***	8.6e-05	2.9e-04	***	1.0e-04
Inc_pay	-9.3e-06		7.4e-06	-1.3e-05		8.3e-06
Inc_ASC	2.8e-04	***	8.0e-05	3.0e-04	***	9.0e-05
Log-L	-1531.6516			-1543.9215		
Adj-Pseudo R2				0.1458		
Waldchi	78.89			305.27		
Prob >chi	0.0000			0.0000		
N (choices)	4803			4803		
N (cases)	1637					
LR test for IIA P>chi2	0.0203					

Robust standard errors have been used. (*) denotes significance at the 10% level, (**) at the 5% level and (***) at the 1% level.

5.2.7 ASC model

Excluding those responses considered protests, the status quo was seen to be the preferred choice in just over half of the choice sets (55.1%). However, 221 respondents deviated away from the status quo (the ASC) in at least one choice set within the CE. This suggests that the status quo was the dominant choice in a number of the sets presented. This is expected as the sets were randomly chosen each time and great variation within fisher's preferences led to few other cards being predominantly chosen.

Table 11. ASC model specification

	Base model: nested			***Base model: conditional***		
	Coeff		SD	Coeff		SD
Closure	-0.015	***	0.005	-0.016	***	0.003
Net_small	0.084		0.140	0.093		0.137
Net_large	-0.759	***	0.147	-0.788	***	0.133
Payment_US	0.074	***	0.104	0.077	***	0.008
ASC	0.907	**	0.407	0.946	**	0.389
ASC_inpark	-1.529	***	0.199	-1.535	***	0.198
ASC_illegal	0.489	**	0.198	0.491	**	0.198
ASC_earnings	0.228	*	0.117	0.228	*	0.117
ASC_land	-0.014		0.024	-0.014		0.024
Log-L	-1403.9111			-1403.976		

Adj-Pseudo R2		0.2018
Waldchi	230.73	258.10
Prob >chi	0.0000	0.0000
N (choices)	4803	4803
N(cases)	1601	
LR test for IIA P>chi2	0.7186	

Robust standard errors have been used. (*) denotes significance at the 10% level, (**) at the 5% level and (***) at the 1% level.

Sixty-eight respondents picked the status quo in all 6 choice sets, 21.5% of the final sample. Given this fairly large selection of the status quo, a further model was run to determine those characteristics most likely to influence this choice. The ASC model is displayed in Table 11. All attributes retain significance within this final model. Coefficients remain fairly consistent in both magnitude and direction. When interacted with the ASC dummy, those who used illegal gear (illegal) and fishing earnings (earnings) entered the model positively and significantly. Land owned (land), taken as a proxy for dependence upon fishing whereby larger land holdings allowed further diversification, showed no significant influence on choice of status quo. Location, i.e. those living within the park, (inpark) was seen as a negative determinant in ASC choice, e.g. those living outside of the park showed a higher reluctance to move away from the status quo.

6. Discussion

Design of PES restriction options was seen to influence scheme adoption rates by local fishers. Similar results have been shown in studies in terrestrial PES-like AES (Espinosa-Goded et al. 2010; Ruto & Garrod 2009). Fishers indicated heterogeneous preferences for various marine PES restrictions, indicated by the different utilities associated with the two attributes investigated. Results were comparable across both the NLM and simpler CLM for all regressions.

6.1 Trade-offs and participation

As expected, increasing restrictions negatively influenced adoption of PES schemes, and higher compensation payments increased adoption. PES programs were associated with a high utility loss by fishers; the PES management scenario with the lowest restriction (a closure of 10%) reduced fisher utility by US$ 14.3 per week (Table 7): 83.6% of mean weekly earnings. A closure of 25% to current fishing grounds was associated with a slightly higher utility loss of US$ 16.7 a week, almost the average weekly earnings of fishers in the area (US$ 17.1). Furthermore, restricting legal net meshing to a minimum of 6″ from 3″ had an associated weekly utility loss of US$ 30.0, nearly twice the mean fisher weekly earnings.

Perhaps more interesting than these absolute values are the trade-offs and respective utilities associated with the management restrictions in question. Often marine closures are met with local resistance and gear restrictions can be more readily acceptable (Cinner et al. 2009a; Christie 2004; McClanahan & Mangi 2004). However within the communities surveyed here, it appears that gear restrictions, more specifically the utility loss associated with net restrictions may be met with greater opposition. Fishers equated a restriction of an additional inch on mesh size as approximately similar to a closure of 20%. Accounting for the ASC value, the loss associated with the prohibition of fishing with meshing less than 6″ (weekly compensation of US$ 22.1) was broadly consistent with, if only a little larger, than the compensation associated with a 50% closure (US$ 20.6). However, a 50% closure might appear as a much more extreme intervention from a management perspective.

It should be noted that the net restriction presented herein is a very specific gear restriction, and may have met with such resistance due to local circumstances. Within the Mtwara area, seizure of inappropriate gear is commonplace and carries with it the confiscation of accompanying catch and boat. In recent years, Tanzania implemented a law which outlawed the use of any nets with mesh sizes smaller than the 3″ used as a baseline within this study (Dadi 2010). From local focus groups and follow up survey questions, many local fishers felt that even the use of these baseline nets were ineffective at catching adequate fish as overall fish sizes within the coastal areas are small. In addition the most commonly used boat, a non-motorised canoe, did not enable access to the more productive and deeper water areas where fish are larger and more abundant. Indeed, as seen in Table 10 higher earners were more likely to prefer those PES interventions which restricted net meshing to 6″, perhaps due to the improved ability of larger boats to access deeper waters where larger fish can be caught.

In addition, the lower unit utility losses relating to marine closures could be explained due to a perception that these closures are harder to enforce, hence easier to ignore. Within the area, marine park officials have attempted to monitor possible closed areas with little effect. Moreover, fishers may, quite rightly, believe that their activities can be displaced to new fishing areas outside of the restricted zones, hence decreasing the utility loss associated with this management restriction.

6.2 Resistance to change

Another interesting, although perhaps not unexpected, finding was the high utility loss associated with any deviation away from the status quo. When calculating the predicted rates of adoption, increasing the level of attribute restrictions resulted in only a mild decrease in adoption rates compared to the initial PES implementation in the first place. For example, increasing the closure restriction from 10% to 25% was associated with a drop in adoption of only 4.9% when offered 5,000 TSh per week (US$ 3.5) and 4.2% under a weekly compensation package of 20,000 TSh (US$ 13.8). Yet, approximately one third and one half respectively were unlikely to adopt a PES with minimum restrictions in the first instance under the same payment schemes (70.4, Table 9b; 53.0, Table 9a). Moreover, results indicated that fishers would be willing to pay as much as US$ 12.7 (74% of fishers' weekly income) to retain the current management practices, once all attributes had been controlled for.

As many as 21.4% of the final sample chose the status quo in all choice sets. Status quo bias is well documented within the CE decision making literature (Boxall et al., 2009; Samuelson and Zeckhauser, 1988). When faced with choices between new alternatives and the status quo, individuals unduly choose the current situation. This decision to remain with the status quo can be motivated by protest beliefs, an inaction to choose, an inability to engage with the more complex experimental design of CE or a genuine preference for the current situation (Meyerhoff and Liebe, 2009). An attempt to limit the incidence of these former three groups was made through the use of a simple and relevant attribute design within the CE. In addition, those respondents who picked the status quo in all six choice sets and did not provide appropriate follow up reasoning were omitted from the final analysis. However, a status quo bias was still noted within the data. Unlike much of the proceeding work in CE and environmental goods, the research herein relates to an initial loss by fishers and not an obvious utility improvement (e.g. loss of fishing grounds and a reduced ability to catch fish), although hopefully with some environmental improvement in the not so distant future. The literature indicates that changes which are considered detrimental (e.g. losses) loom larger on a respondent's mind than any improvements or gains (Kahneman et al., 1991). For this reason, fishers may have shown greater hesitation to participate.

On further analysis it was seen that certain groups were more likely to choose the status quo. Those individuals living outside of the marine park, where current enforcement is weaker and communities have less experience with enforcement bodies, were less likely to choose adoption of an alternative management scenario. In addition, those fishers who had illegal gear (e.g. nets with mesh <3") were more likely to stick with the status quo, even once net attributes had been controlled for. Again, within this sub population, it seems reasonable to expect resistance to change. Illegal fishers are likely to be more dubious of local authorities and the increased restrictions, having had more negative interactions with relevant authorities and perhaps viewing them as less legitimate (Crawford et al. 2004). Fisher perceptions of legitimacy have been shown to be important determinants in compliance behaviour (Hønneland, 2000). Moreover, illegal fishers already function under the base requirements perhaps making adoption of required gear more difficult and costly.

It was also noted that fishing income was a positive determinant for selection of the status quo. This is an interesting finding. Indeed in many WTP studies, income signifies a budget constraint and is used as a validity test within case studies (Schläpfer 2006; Mitchell & Carson 1993). However, in this circumstance it is a compensation value (a WTA) which is being analysed and income is not a constraint. Indeed, one might expect that those fishers who earn less would be willing to accept less as compensation. Here the selection to remain with the status quo by those who earn more is interesting if perhaps not totally unexpected. Bigger earners, more likely boat owners with high investment into the sector, are likely to be fairly happy with the current perceived situation and reluctant to induce any changes or impose new risks which may impact upon this. Similar findings have been seen with respect to fisher resistance to change practices (e.g. exit a fishery). Pradhan and Leung (2004) found that potential annual fishery earnings was a significant positive determinant in fisher's reluctance to exit fisheries. The same study also indicated those vessel owners who fished using their own boats (e.g. not absentee owners) were more likely to remain.

Similar results relating to ownership were seen by Ikiara and Odink (2000). Furthermore, it could simply be a case that the weekly compensation rates offered within the CE were simply too low for higher earner to make adoption worthwhile. Furthermore, when socio-demographic variables were entered into the model the dummy for retention of the status quo was no longer seen to be significant. An interaction term between fishing income and the ASC was seen to be a strong significant positive determinant of status quo choice. This provides further support that those higher earners were more likely to stick with the status quo.

6.3 Implications for marine PES

Perhaps two of the more interesting findings are as follows. Firstly, although various attribute levels influence management adoption, hence acceptance, it is possible that within those coastal areas creating an environment whereby change is not met with apprehension and hostility could be equally as important, if not more so. Deviation away from the status quo carried with it a high initial utility cost, comparable and greater than those associated with the restrictions themselves. In such cases, efforts to support local communities, build trust and ease transition to new management practices may be more fruitful and cost-effective, if albeit a little more time consuming at the on-set.

Secondly, overall the cost of a PES scheme may be too high. The hypothetical PES scheme which offered the lowest compensation of US$ 3.5 per week to fishers for a restriction of 10% closure is estimated to be adopted by only 50% of the target population. Moreover, a PES offering a much higher weekly compensation of US$ 13.8 for the same minimal restriction failed to entice as much as a third of the population. While this may not seem like much, it must be noted that compensation is based on a weekly payment and must be aggregated for an entire fishing community.

Furthermore, results indicated that income is a positive determinant for opting out of PES management change. If weekly compensation rates cannot entice higher earners, who undoubtedly are often the highest extractors of the resource, PES schemes are unlikely to accomplish conservation goals (Engel et al. 2008; Wunder 2007). Indeed, within coastal communities fishing incomes can vary widely with some fishers barely catching enough for subsistence, let alone commercial activities, while other can be considered well off by local standards. Payments may be required to reflect all of these population groups, perhaps via differentiated payments. However, differentiated payments bring with them increased opportunity costs and can induce conflict between parties (Jack et al., 2008). Alternatively non-cash incentive structure could be structured and introduced to induce participation. For example, access to storage facilities may enable fishers to better negotiate prices and would increase profits relatively for all fishers involved, so long as access is not monopolised.

6.4 Limitations and future research

In order to reduce the cognitive burden associated with CE, design was limited to two attributes, closure and allowable mesh size, with four and three levels respectively. However, this design limited the ability to report on trade-offs and design of appropriate restriction levels. For example, the restriction on small meshing was seen as insignificant. Therefore for gear management restriction was limited to only current and large meshing and limited the management scenarios available.

In addition, that utility loss from a 50% closure of current fishing areas equated to that of an 3″ increase in mesh size may generate concern that respondents were unaware of what they were being asked. However, as previously mentioned, it is not unreasonable that fishers might value these smaller meshed nets so highly given local circumstances.

Despite these limitations, the findings herein could be the valuable subject of on-going investigation. Future studies may aim to move beyond this case study and replicate research. In addition, there is scope for more detailed work on those further attributes fishers may respond to, in terms of both restrictive strategies as well as what non-monetary incentives that may induce participation e.g. access to improved markets and storage facilities to name a few.

It will also be useful to identify if those attributes identified herein, as well as additional attributes so far not addressed, continue to be significant determinants over a wider sample of artisanal fisher communities. What similarities lie within case studies as well as those site-specific qualities?

Given the large utility loss associated with a movement away from the status quo, it would also be informative to identify whether this is a common feature within fishing communities. Indeed, as previously noted, reluctance to exit fisheries by fishers has been identified within recent studies (Cinner et al. 2009b; Teh et al. 2008; Pradhan & Leung 2004; Ikiara & Odink 2000). This inertia to change may also transcend into less extreme novel management strategies. On the other hand, the relatively large utility loss recorded herein could relate to site conditions; at least in part, local conditions are anticipated to have played some role in the magnitude of this perceived loss. For example, those communities located outside of the marine park were more likely to stick with the status quo, perhaps due to a greater mistrust of or a reluctance to engage with new and less known regulating bodies. Further studies should identify those circumstances which have culminated to produce this effect as well as those fishers more likely to perceive a loss, as well as those PES interventions which will mitigate this loss.

7. Conclusions

Overall the study finds CE to be a useful policy tool in identifying fishers' preferences for various management options. CE enables explicit analysis of trade-offs, as well as and their appropriate levels. CE can assist in evaluating which management alternatives may be of least-cost as well as locally accepted and effective in their conservation goal. This will be key in the concurrent design of appropriate conservation and development tools and in particular cost-effective PES. The CE methodology can also identify those groups less willing to engage in such novel schemes, as well as identifying those aspects of instrument design which may disincentivise participation; in doing so CE can help recognise whether the restrictions are inappropriate if there is a reluctance for change overall.

The research shows that fishers are currently reluctant to move away from the status quo, and that associated costs in promoting this transition will be high. Mechanisms which reduce this initial transition cost are called for, as are conditional non-monetary incentives which can allow fishers to sustain their welfare at a lower cost.

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